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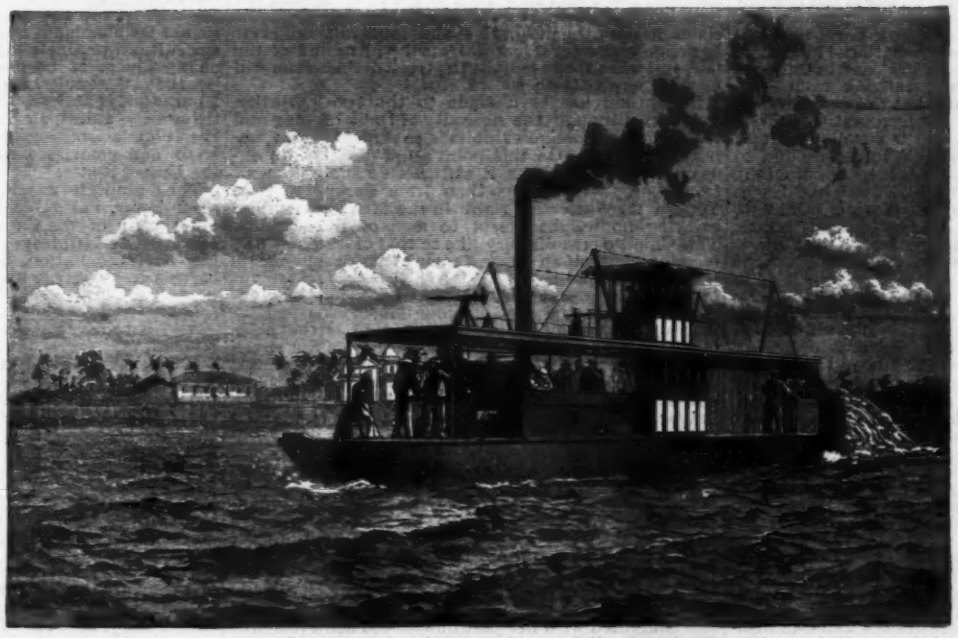
DELAGOA BAY.

THIS bay marks the southern limit of the Portuguese coast, and is the best harbor in East Africa. The bay is extensive, but the real harbor is fifteen miles across, and here the navigable portion is from six to twelve and in some places twenty fathoms. Three large streams empty themselves into Delagoa Bay—the King George, the English River, and the Maputa. The silt deposited by these streams has caused shallows and flats, which render the navigation of the bay somewhat difficult. English River forms an excellent landlocked harbor—indeed, the only one for large ships between the Cape and Mozambique.

Delagoa Bay really means the Bay of the Lagoon or the Marshes; the shore being low and covered with marshes, which renders the district exceedingly unhealthy. The town of Lourenco Marques is built on a tongue of land on the left bank of English River, in the northwest part of the bay. The port itself is not accessible to very large vessels, though it might easily be made so. The town was founded so long ago as 1544, but until recently it was little more than a factory. In 1824 there was only one stone house, surrounded by huts. The actual town was begun in 1867, and completed in 1869. It consists of houses and gardens surrounded by a rampart, with bastions armed with a few small guns intended for defense, not against a sea attack, but from the attacks of the natives. The fortifitions, such as they are, are reported in a dilapidated condition. Still there is considerable commerce at the port, the trade with Natal alone averaging £150,000 annually. The name of the town has been familiar for some time as the starting point for the railway to the Transvaal frontier, reached some time ago. The seizure of the railway and its plant by the Portuguese some months ago will be remembered. The town is very unhealthy, owing to its being surrounded by marshes, which the Portuguese have made no attempt to drain. The population is a little over 8,000. Lourenco Marques is the chief town of a district the total population of which is about 80,000, of whom not more than one hundred are Europeans.—*Illustrated London News.*

DELAGOA BAY, SOUTH AFRICA.



PORTUGUESE GUNBOAT ON THE ZAMBESI.

[FROM ENGINEERING, LONDON.]

THE UNITED STATES EXHIBITION OF 1892.

THE brilliant success of the recent Paris exhibition no doubt did much to foster, if it did not suggest, the idea to American visitors that the time was fast approaching when a similar great international celebration should be held in the United States. The idea, which, it is needless to say, will receive the warmest support from this country, having taken shape, it was only natural and characteristic that it should be at once acted on, and a suitable reason for the country to hold such an exhibition in 1892 (that it may celebrate its own discovery 400 years before) was speedily found. Passing rapidly from schemes to action, the exact location came on for discussion—that is to say, in what part of New York the exhibition should be held. But before this was fully decided, a bold and unexpected bid for the undertaking was made by Chicago, whose citizens advanced a strong claim to have the exhibition held in their city, and they sent as a delegate, to London and Paris, Mr. Edward T. Jefferey, president of the Amalgamated Association of Railways centering in Chicago. The object of this visit was to ascertain the public feeling on the subject in Europe, and to obtain information on the administration of the Paris exhibition. The question of locality is one of very great interest to Englishmen, but it would be presumptuous in us to discuss the relative merits of New York and Chicago. Feeling, however, that the subject is one that should be properly considered in our columns, we asked our New York correspondent to furnish us with some of the leading arguments in favor of New York, and at the same time we requested Mr. Jefferey to formulate the claims of Chicago. We now take pleasure in publishing both these communications without comment, feeling assured that the question can only be properly treated by those most deeply interested in it.

THE CLAIMS OF NEW YORK. BY OUR NEW YORK CORRESPONDENT.

When the writer was asked to give reasons why the world's fair should be held in New York City in 1892, his first impulse was to decline on the ground, well known to beginners in mathematics, that "an axiom was a self-evident proposition." One might as well ask why London was the clearing house of the world, and the answer would be couched very much in terms of the proposition that a draft on London was negotiable everywhere. But the reflection that all English speaking people are not perhaps as familiar with the reasons so plain to Americans has led to this article.

Money being the foundation of most enterprises, it might be well to contrast the relative amounts guaranteed by the respective cities of New York and Chicago at the outset. New York has, up to the present time, raised with very little effort $5,200,000. This has been done simply by sending around subscription books handed to the proper persons with no remarks by the solicitor. If a party subscribed $100 he was not asked to make it $200. The subscriptions have appeared in the daily papers and are all *bona fide*.

Chicago, on the contrary, has published lists in bulk, has brought pressure to bear, and in spite of all this cannot show one half New York's subscription. In some instances amounts have been placed against certain firms without even consulting them, and these were counted in the general amount as though they had been offered. In one instance, the writer was told by a manufacturer whose business is in New York that he was notified that his Chicago agency was put down for $3,000, and was further told if they did not pay it, they need not try to do any more business in Chicago. He wrote in reply that he hoped the fair would be held in New York and would not give a cent to help any other locality. Another item of consideration is the relative populations of the two cities. New York City has a population of 1,600,000. Brooklyn, connected with it by the East River bridge, numbers 900,000; Jersey City and Hoboken, on the opposite banks of the Hudson River, contain 300,000; while but nine miles distant is Newark, New Jersey, with a population of 200,000. Moreover, within a radius of twenty-five miles around New York, not counting any of these places named, are many suburban towns numbering in their population hundreds of thousands. Take, for example, three miles from Newark, are the Oranges, with over 30,000, and all along the Hudson River are towns of similar numbers, for New York lies in the midst of a thickly settled district, while Chicago is comparatively alone, no city of any size being reached until you come to Milwaukee on one side and Springfield, Ill., on the other. In other words, the district is very much like the beard of a budding youth, "largely laid out but very thinly settled." So much for the item of population in the immediate vicinity of Chicago, but when attention is drawn to the cities of size near Chicago, the discrepancy is even greater.

Eighty miles from New York is Philadelphia, with a population of 1,200,000, and seventy-five miles the other side is New Haven. Boston is 225 miles, Baltimore 170 miles, and Washington 215 miles, not to name numerous large cities lying between, such as Providence, Rhode Island, Springfield, Mass., Trenton, N. J., and many others. So that the immediate section lying around New York, from which it has largely to draw upon for its visitors, is at least ten times as thickly populated as that within the same radius around Chicago, for Chicago offers about as much as Brooklyn alone, and nothing of size very near it.

Again, view the natural advantages of the two cities. New York is situated on the Atlantic Ocean, and is the seaport of the United States. Many of the places named are accessible by water; the shores of the Hudson and of Long Island and the Sound of New Jersey are dotted with towns and teeming with inhabitants, while the location of the fair is such as to be readily reached by boat. Many boats will be run at short intervals from all places within a suitable distance, and from other places there is no doubt that boats with state rooms will be plying, so as to furnish sleeping accommodation for their patrons in transit.

None of these advantages are possible in Chicago except on a small scale.

In this connection let us contrast two realistic pictures. A party of Cook's tourists start from Liverpool to see the fair and the metropolis of the United States, for a round trip, with a limited ticket, and having but a short time at their disposal. On reaching New York their steamer goes to the fair wharf and drops anchor in a convenient place. After seeing the fair they return to their steamer and live on board, without bother of transfer of baggage or any of the annoyances of an hotel. The nights, even in the hottest months, are cooled by the breezes of the Atlantic, and they return home in equal comfort. On the other hand, if Chicago is their goal, they must disembark at New York, "go through the customs" with their baggage, find an hotel, and on the following day travel thirty-six hours in a hot and dusty sleeping car to reach Chicago, whose hotels to-day are inadequate for the visiting population, and then they must find the fair, which, as yet, has no location. This thirty-six hour trip must again be taken on the return, and when the voyager reaches the steamer to return to Europe, he wonders, time and again, how he ever could have been such an idiot as to think it was going to be a pleasure trip to visit Chicago.

Next as to the site chosen. New York has selected a beautiful one, easy of access, with fine views of the bay and sound, and in every respect an ideal and picturesque location. So far as heard from, Chicago had not selected a site, but according to its own papers did not dare do so at present, as there was such jealousy between the two sides of the city that they feared the rivalry would seriously affect their position as claimants at Congress.

New York is perhaps the most attractively located city in the world. Situated on an island with rocky scenery on the New York side, and hills on the Long Island, at the head of a bay which is said by many to equal the celebrated one at Naples, and with an immense body of water on either side, what greater natural advantages could be desired? Chicago, on the contrary, is on the shore of Lake Michigan, and so far as that side is concerned, it is all very well, laboring, of course, under the disadvantage of having fresh water adjacent instead of salt; but on the other sides the country is flat, with little foliage and considerable swamp land; originally, of course, it was all prairie. The writer ran a line of levels near Chicago for one mile, with the variation of only one-tenth of a foot along the route, and at the end; 17 miles from Chicago, the city can be readily seen, and is overhung by a dense cloud of smoke due to the combustion of soft coal.

New York, again, is far healthier, is better drained, and has the invigorating salt air to draw upon at all times. At night, even in the hottest weather, there is a cool ocean breeze. The writer has lived in Chicago in summer and winter, and will readily give it the palm for the greatest variations in temperature. In the summer the air is dead, but revives in winter, and makes up the average with a vengeance. On one piece of engineering work there his party were obliged to erect screens around their instruments, since the wind was so violent as to render observations unreliable, and the party froze their ears, noses, hands, and feet. In this connection the last report of the Board of Health is not uninteresting.

New York City, with 1,600,000 population, had a mortality for the week ending November 30, 1889, amounting to 566, while Chicago, with 800,000 to 900,000, had for a month 1,634, ending October 31, one of the healthiest and pleasantest months in this lake region. The annual death rate per 1,000 is, in New York, 18·5, and in Chicago, about one-half its population, 17·82. The mean temperature in New York is 39·9°, and in Chicago, in spite of its terrible winters, ranging from —20° to —30°, it is 49·4°. This shows what the summer heat must be, since the extreme winter temperature in New York seldom runs below —10°, and is usually about 0°. Since children are more susceptible to disease due to atmospheric changes and bad drainage, etc., it might be noted that New York, with its 1,600,000, has deaths under five years amounting to 188 per week. Chicago, with 800,000, has 707 per month. London's death rate, with a population three times that of New York, is 2,532 per week. These points are emphasized because some Chicago man has claimed that we were located in an unhealthy region.

The inhabitants of Chicago, moreover, drink impure water whenever they drink any; the lake into which the sewage is deposited furnishes thus food and drink for them. If one desires to realize the full beauty of this, just stand for a short time on the banks of that filthy stream dividing the city called the Chicago River. So much for the natural advantages and disadvantages. It is further the height of presumption for Chicago to try and hold such a fair, whose scope they do not begin to realize, and whose needs they have the most inadequate ideas of. The city, as stated, has not the means to accommodate the ordinary visitors. A single convention of any size sends the hotels in despair for the guests' accommodation. A national base ball meeting is about all they can cope with, yet they aspire to entertain millions for months. There is, however, as stated, plenty of prairie land adjacent, and if our foreign visitors can only deal with the owner, if he can be found, for all the titles there are not well established, and take the precaution to bring tents, they might "camp out" and save their shoes in hunting for rooms, but then they will ruin their shoes in the prairie mud, which ranges from 10 in. to 10 ft. in depth all around this assumptive city.

The access to Chicago by rail is, of itself, a great obstacle. There are a large number of railways entering the city, and the surroundings being perfectly flat, they cross each other at grade. The result is that when within a few miles of the city the train must make frequent stops, and in the case of the Pennsylvania limited, the writer was told a full half-hour is lost from this cause. What the delay and risk would be when frequent trains necessitated by a world's fair are moving toward this center can be readily imagined. The truth is this whole matter is so far beyond anything the majority of Chicagoese ever dreamed of, that they fail to grasp even the magnitude of the initial steps.

Another matter which bears more directly on foreigners is the state of society in Chicago. The place having but recently grown into notice, has all the mannerisms and customs of a frontier town, softened somewhat by the association with the more cultivated East. In time, no doubt, the effect of this intercourse will be to show them their lack of refinement, and to instill into these semi-denizens of the wilderness politeness, morals, and culture.

Society there has a free, off-hand manner of dealing with its social problems; divorces are extremely common, and the facilities for obtaining them are abundant; naturally then the social tone is much lower than at the East. Sunday theatricals are frequent, and it is but recently that the whole nation has been shocked by the carefully planned and most thoroughly brutal murder of the age. Nor is Chicago a well-governed city in its municipal affairs. Such a riot as that precipitated by the anarchists would be impossible in New York City, and the police here would have crushed it before it took shape, thus saving the lives of many brave men. Moreover, the same spirit which prompted the riot is still active, utterances are allowed there to-day which would send the speakers to Sing Sing or Blackwell's Island if made in New York, and there is reason to fear the smouldering fire may break out at any moment.

As a most undoubted proof of the foregoing, look at the literary condition of Chicago. Its daily papers, which are supposed to reflect the sentiments and taste of its people, are filled with ample and amplified reports of all the criminal trials, many unfit for the perusal of a family, the baser the crime the more prominent the head lines in the journal. Such papers would not be allowed to circulate in England. As for literary and scientific journals, there are none of any standing. Several which have been started there have been promptly moved to New York, not finding among the Chicago people sufficient support for their existence. There are no literary works of standing issued from that city.

Now the writer does not desire to malign Chicago, these matters are incidental to a new civilization; New York has been through all this, so have St. Louis and Cincinnati, and Chicago will undoubtedly emerge in time and prove a most brilliant gem in the coronet of Liberty, but the time has not yet arrived; there is a certain amount of ephemeral growth, but it is not a solid, permanent development. She has asserted herself as a great city, and so she is, but if she will only compare herself with New York instead of looking around at the prairies, she must notice there is no basis even for a comparison. New York is the social, the literary, the commercial, and the moneyed center of the United States, and there it will remain. Here is where all nations flock, and it must be so, as long as the channels of trade run in this direction. Naturally, the brains of a country find support at its mercantile center, and they will just as naturally gather there.

Finally, it may be said, the methods pursued by Chicago to obtain the fair are the very best evidence of her unfitness to hold it.

The manner of obtaining money or attempting to do so, from the stranger within her gates, has already been noted. She has openly boasted of her ability to obtain (?) the influence of various congressmen; there is a delegation at this minute keeping "open house" in Washington at the expense, it is stated, of $1,000 per day, and a party have been sent to Europe to influence foreign governments and to take the dimensions of the French buildings. Now these last two steps are most emphatically un-American. We claim here to be a nation quite jealous of our national prestige; the location of the World's Fair is a purely American act; no foreign ideas ought to have the slightest weight in this decision, nor would New York be guilty of copying the buildings in Paris, however fine they may be. We claim in our own city brains and ingenuity sufficient to design and erect structures worthy of us and of the fair, and when they are built the truth of that claim will be most emphatically shown.

No allusion has been made to the transportation question, although the necessity of transshipping and rehandling all foreign exhibits is so evident as to appeal to any one. On this point a few fanatics are endeavoring to show that it will cost no more to send from Europe to Chicago than from Europe to New York, a mere assertion right in the face of facts, and carrying no weight except to men of like fashion. This Chicago craze is very like to that of the frog who imagined himself an ox, and some of its developments border on the ludicrous. It is said that posters are put into a man's hat and left at a hotel while dining; are distributed on the streets, and put in conspicuous places, all of them stating that Chicago is the place for the fair. The writer has received letters the envelopes of which bore this statement in four or five places, and Mr. Depew says that even religious exercises are not exempt from this innovation, for picking up a prayer book, he found the universal poster inside, and in one case it was inserted so as to read thus: "Cherubim and seraphim continually do cry, Chicago is the place for the World's Fair."

To a New Yorker this seems amusing indeed; one looks on very much as a cat watches the antics of her kittens; if they get too bold, she will give them a friendly cuff to call their attention to the limit of their nonsense and admonish them to keep their crazy actions within some sort of bounds.

Good and friendly advice to this young city would be to restrain her noble rage, and for the present to rest contented with her past undoubted achievements. She has a well-deserved reputation for enterprise and energy, but should not on this account reach for the impossible. Such efforts only serve to make her ridiculous, and the more she advertises them at home and abroad, the greater will be her mortification at her failure. Let her call in her foreign embassy and her lobbyists at the national capital, and let her bide her time, for the fair of 1892 is beyond her in every respect, and in her hands would be entirely unworthy of either Chicago or the United States, while its location there would engender an unworthy strife with other great Western cities having equal claims; Chicago's turn will come, perhaps, in the next 400 years at the second celebration.

She will then know more, it is believed, and will understand that "bluff," while good in her favorite game, will not influence outsiders, and that noise does not make one famous, but objectionable; let her young men tarry at Jericho till their beards are grown. Meantime, New York, the metropolis of the United States, the most cosmopolitan city of the world, will wait with calm dignity to take the fair in hand at the proper time, having already shown what she can do by a voluntary subscription backed by no pressure of any kind, and being ready to double, treble, quadruple, or quintuple the amount whenever the question of location is decided.

Chicago coming to this fair will learn how to carry on this enterprise, will have her ideas enlarged, her imagination stimulated, her æsthetical taste developed, so that when she does have a world's fair it will be in every respect all it should be, and neither an overgrown county agricultural exhibit nor a pitiful attempt at copying the great Exposition Universelle of Paris.

THE CLAIMS OF CHICAGO. BY MR. EDWARD T. JEFFERRY.

The unrivaled attractions of the Paris exposition, and the astonishing success which crowned the undertaking, direct public attention to the complicated world's exhibition in the United States in 1892. That one will be held is beyond doubt, and the prediction may be made with certainty that Chicago will be the chosen location for it; not because the citizens of the United States are without pride for their great seaport metropolis, New York, but because Chicago is to a greater extent more characteristically American, more centrally located, and in many other respects better suited as a location than New York. All thoughtful and intelligent persons in the United States are not only ready to claim, but proud to prove that New York is the great point of import and export on the Atlantic coast, and they are equally proud of the rapid growth, the vigor, activity, energy, and commercial power of Chicago. It is well recognized that New York is the channel through which passes a large proportion of the articles Americans buy from foreign countries, and of the products they sell abroad. But it cannot be assumed, nor is it admitted, that because these things bought or sold by over sixty millions of people pass through the port of New York, that city or the territory adjacent to it is the seat of consumption for imports and of production for exports. Nearly everywhere throughout the Union, articles for export have origin and articles of import have consumption. The consumption within the United States of articles of foreign production is spread over a vast area of territory, and Chicago is indisputably nearer to the great body of the consumers than the city of New York. People travel where they trade. Therefore, it is fair to assume that those who live in foreign lands, and sell to people within the United States, will be impelled by motives of personal gain, as well as by curiosity, to prefer an exposition located in the interior of the country rather than upon the Atlantic seaboard.

Chicago, upon the southwestern shore of Lake Michigan, has a peculiarly desirable geographical position, and in many essential points is situated differently from, and more advantageously than, any other commercial metropolis in the world. The great chain of fresh water seas to the north, northeast, and northwest of it, floating a vast merchant marine, make it a port of first importance, nearly equal in tonnage with New York.

During the year 1888, 10,989 vessels, with an aggregate registered tonnage of 4,393,768 tons, arrived at Chicago, and the clearances of vessels were 11,106, with a registered tonnage of 4,496,898 tons. Vessels drawing 15 ft. or 16 ft. of water can sail from London to Chicago, *via* the St. Lawrence River, the Welland Canal, and the great lakes or inland seas.

For a distance of 900 miles northwest from Chicago, an equal distance west to the Rocky Mountains, the same distance south to the Gulf of Mexico, and about the same east to the Atlantic seaboard, there are the richest farming lands and the greatest and most diverse agricultural products to be found upon any one continent. The great basin or valley bounded on the east by the Alleghanies, and on the west by the Rocky Mountains, is drained by the Mississippi River and its tributaries, and this valley embraces the great bulk of the population, agriculture, manufactures, inland trade and commerce, railway mileage, and wealth of the United States.

The main waterway is, as indicated, the great Mississippi River, navigable from St. Paul, Minnesota, 250 miles south of the Canadian frontier, to the Gulf of Mexico. And Chicago, the center of trade and commerce of the nation, is situated about 140 miles east of this great river, with which it is connected by numerous railroads, and by a continuous waterway extending from the Chicago River by canal to the Illinois River, and then to the confluence of that river with the Mississippi.

Chicago is the greatest railway center in the world. Twenty-three of its systems comprise railways varying in length from 600 or 700 miles to 7,000 miles. Among the great systems having Chicago as a terminus are the Pennsylvania, the Vanderbilt system, the Chicago and Northwestern, the Chicago, Milwaukee, and St. Paul; Chicago, Burlington, and Quincy; Atchison, Topeka, and Santa Fe; Chicago, Rock Island, and Pacific; Chicago and Alton; the Illinois Central, and many others. Eight hundred and fifty trains arrive at and leave Chicago daily.

The running time of the passenger trains between the Atlantic seaboard and Chicago is twenty-five hours, and they are thoroughly equipped for comfort of passengers and ease of travel. The sleeping cars, dining cars, library, and smoking cars, provided with a bath room, barber shop, and other conveniences, relieve the journey of all its unpleasant features and the travelers of fatigue.

Visitors from other lands will be charmed with the beauties of the Hudson and impressed by the grandeur of Niagara Falls. The varying landscape, with its great fields and farms; the succession of cities, towns, and villages; the evidences everywhere of prosperity, will afford ample food for reflection; and when at Chicago, a few hours' ride will enable those who desire it to visit St. Louis, Omaha, Milwaukee, St. Paul, and Minneapolis. When homeward bound they can, by taking other routes, pass through Indianapolis, Cincinnati, Louisville, Pittsburg, Baltimore, Washington, and Philadelphia.

The transportation facilities in the city of Chicago are ample for all requirements. Tramcars moved by underground cables traverse the city in various directions, and horse tramways, connecting with these main arteries, afford ready transit from any portion of the city to all others.

The area of the city is now 178 square miles. Its population, including that acquired in extending the

city limits this year, is over 1,100,000. Within its boundaries are the greatest grain houses, and the most extensive pork and beef packing houses in the world. It boasts one of the largest steel rail mills in the United States, and established there are the headquarters of the greatest steel rail manufacturing company in the world. Its population is largely a manufacturing one.

Chicago's growth has been phenomenal. The city was founded about fifty-two years ago. The first election under the city charter was held on May 2, 1835. On July 7 following, a census was taken, which showed the then population as follows:

White	3,989
Colored	77
Sailors on vessels owned in Chicago	104
Total inhabitants	4,170
In 1850 the population was	29,963
In 1860 " "	109,260
In 1870 " "	298,700
In 1880 " "	503,209

And the population is now estimated in the enlarged city limits at over 1,100,000.

The growth in the last twenty years has been achieved in the face of the greatest conflagration of modern times. Three and one-third square miles were burned over, $153,000,000 of property destroyed, and only about $50,000,000 of insurance collected, making the net loss to owners of Chicago property about $103,000,000. The burned district has been entirely rebuilt with structures of stone, brick, and iron, striking architecture, solid in construction, and in design and appearance open to favorable comparison with the business buildings of any other city. The beautiful and commodius Auditorium building, costing nearly $3,000,000, and with seating capacity for 5,000 persons, is now completed.

The receipts of flour and grain at Chicago, in 1888, the former being reduced to bushels, aggregated 182,588,188 bushels. The shipments from Chicago amounted to 156,659,986 bushels.

The storage capacity of the grain warehouses of Chicago is over 30,000,000 bushels.

There were received in Chicago during the year 4,938,413 hogs; 2,611,543 cattle; 1,515,014 sheep; 55,333 horses; the total valuation of which was $182,202,789.

The receipts of lumber amounted to 2,066,927,000 feet board measure.

The number of manufactories in 1888 was 2,400, with a capital of $117,000,000. The average number of workmen was 132,000, who received $74,000,000 in wages, the product of the manufactories being $402,000,000 in value.

In addition to its colleges, academies, and private schools, of which there are many, Chicago has over a hundred public schools, giving occupation to more than two thousand teachers and instruction in various branches of education to over a hundred thousand pupils.

During 1888, over five thousand buildings were erected upon a street frontage of nearly twenty-two miles, at an estimated cost of over $20,000,000.

The amount of bank clearances for the year was $3,163,774,462.68.

The production of bound books in 1888 aggregated 8,000,000 copies, and those in paper covers 2,500,000, which is at the rate of about 35,000 copies daily, and thirty per cent. of these were shipped to markets in the eastern part of the United States. The sales of books aggregated in 1888, 9,300,000, not including maps, directories, and similar works.

The parks of Chicago embrace more than 2,000 acres; they are ten in number, connected by boulevards varying in width from 100 ft. to 200 ft. These parks and their connecting boulevards are so arranged as to make a cordon of beauty from the lake shore on the north, around the city, to the lake shore upon the south.

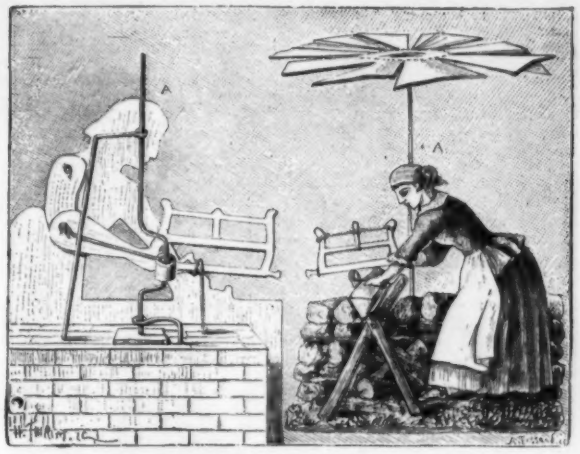
The recent extension of the city limits has placed within them the remarkable manufacturing city of Pullman, an exhibition in itself for observant and thoughtful persons. Planned carefully and in detail before a brick was laid or a spadeful of dirt was turned, it affords a practical illustration of advanced thought in affording not only employment, but in providing for the moral, educational, and domestic welfare of the working classes. Its sewerage and sanitation, its water and gas supply, its parks and their adornment, its workshops, dwellings, churches, schools, library, savings bank, theater and shops and bazars, were all constructed upon a preconceived, artistic, and well arranged plan. At the expiration of eight years from its commencement it stands with a population of 11,000, a monument in stone, brick, and iron to its founder, Mr. George M. Pullman.

To the people of Great Britain, an international exposition in the United States in 1892 should have great significance, and enlist their heartiest support. The peoples of the two countries speak a common language, have common interests, similar aspirations and strong personal and commercial ties. One-quarter of the exports and imports of the United States is from and to Great Britain, about one-ninth from and to Germany, and less than one-tenth from and to France. Of the United States exports, fifty-two per cent. is to Great Britain, about eight per cent. to Germany, and about 5½ per cent. to France.

In 1888, Great Britain, Germany, and France together controlled 45·26 per cent. in value of the merchandise carried to and from the United States, leaving about fifty-five per cent. in value for the rest of the world. As already stated, the great bulk of the commerce was with Great Britain, and in view of this, and of common language, descent, literature and aspirations, it would seem to be a foregone conclusion that the World's Exposition of 1892 in Chicago would receive the hearty co-operation of the people of Great Britain and the official recognition and powerful support of their government.

HOT AIR HELICES.

EVERY one is familiar with the device made by cutting a few slits in a cardboard disk and bending the intervening portions at a certain angle so as to form the blades of a helix, which, when mounted upon a wire axis and placed upon a hot stove, revolves through the effect of the ascending hot air. As everybody knows, such helices are often employed as motors for actuating cardboard devices of various kinds, such as the one shown in the accompanying illustration from *La Nature*, representing a woman sawing wood. The simple and easily constructed mechanism which moves this figure, and which may be varied so as to actuate various others, is so well shown in the back view to the left that it needs no description.



CARDBOARD MECHANISM AND HOT AIR MOTOR.

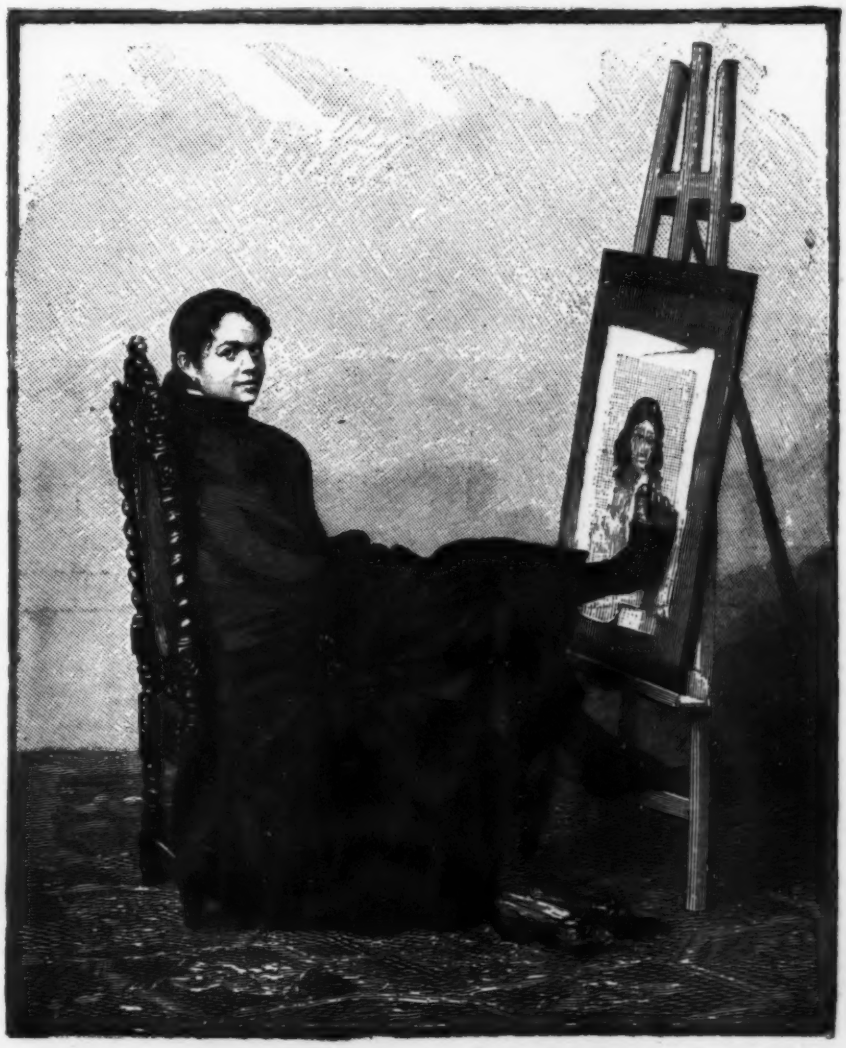
AN ARTIST WITHOUT ARMS.

LESSING'S saying, "Raphael would have been a great artist if he had come into the world without hands," has often been criticised with doubtful smiles, and characterized as enthusiastic exaggeration, but it is true nevertheless. A striking proof that real talent overcomes the greatest obstacles, and has even accomplished what seemed like impossibilities, is now furnished by the young Swiss artist, Aimée Rapin, who has no arms, but knows how to manipulate her crayon in a wonderful manner with her right foot.

Miss Aimée Rapin, whose portrait we give, was born in Locle, in Canton Neuchatel. The otherwise well formed child came into the world with one sad defect, she had no arms. From her earliest childhood she showed astonishing dexterity in using her feet in the place of hands, an accomplishment which improved with her years, and therefore the child's foot coverings were carefully arranged so that the toes should not be covered and confined by the stockings. One day when Aimee's mother was walking in the garden with her little girl, she was surprised to see her suddenly throw off her shoes and pluck a flower with her left foot and then pull the petals off one after the other with the toes of her right foot. After her attention had thus been drawn to the suppleness and dexterity of her child, the mother took pains to cultivate it, and she succeeded beyond her expectations. The child, who was very bright and apt, showed a decided talent for drawing, so that her parents decided, after her school years were ended, to allow her to pursue her studies at the School of Art at Genf, where she soon distinguished herself as the highly gifted pupil. Miss Rapin now lives in Paris, where she is known, not as a curiosity for the public, but as an artist of the first rank. The ease and security with which she holds her brush between the great and second toes of her right foot and guides it over the paper borders on the miraculous; and as she is very quick and clever in discovering resemblances, she has chosen portrait painting for her specialty.—*Illustrirte Zeitung.*

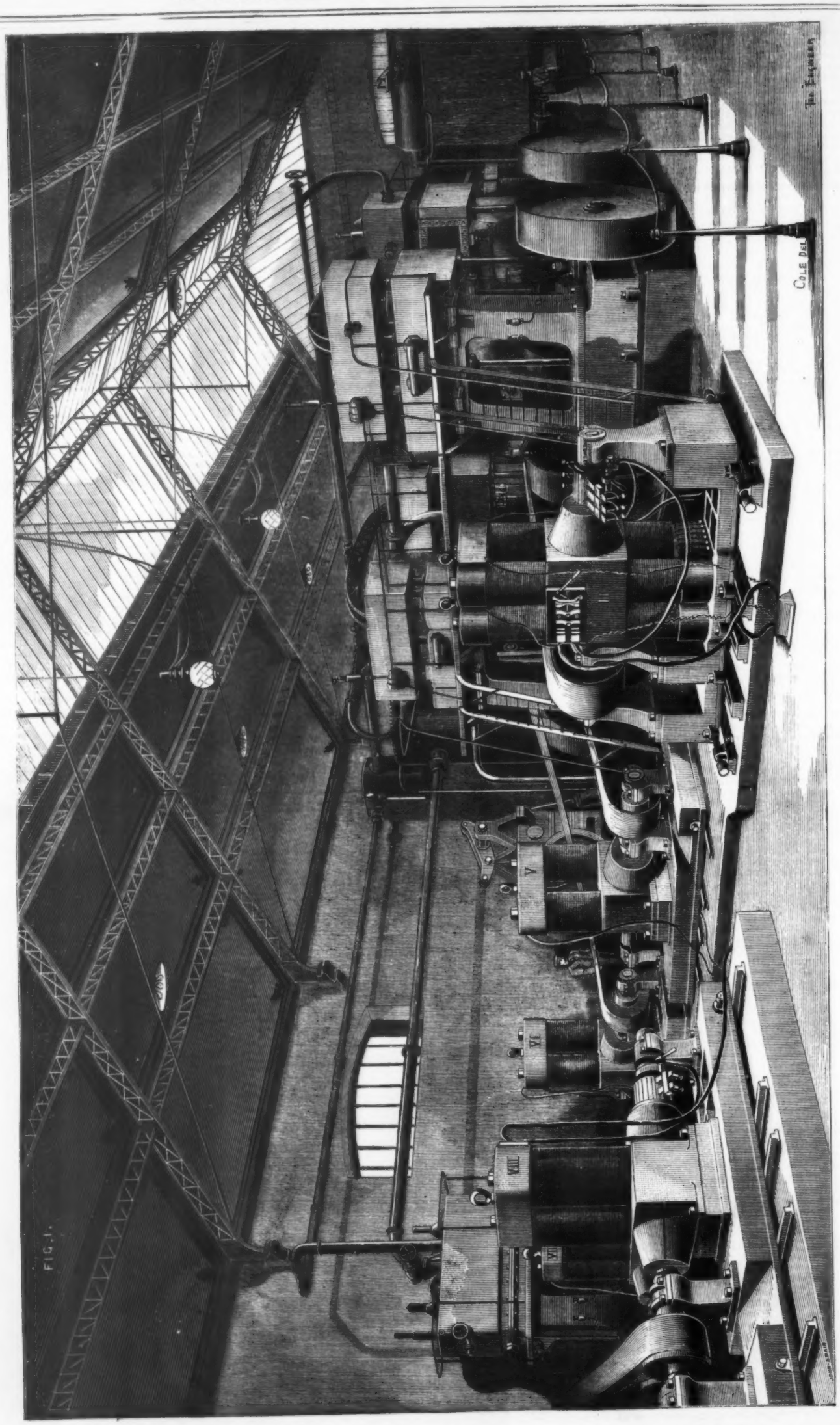
ELECTRICITY OF THE BODY.

AN interesting study has been lately made by Herr Tarchenoff (*Pfluger's Archiv*) of electric currents in the skin from mental excitation. Unpolarizable clay-electrodes, connected with a delicate galvanometer, were applied to various parts—hands, fingers, feet, toes, nose, ear, and back; and, after compensation of any currents which occurred during rest, the effects of mental stimulation were noted. Light tickling with a brush causes, after a few seconds' period of latency, a gradually increasing strong deflection. Hot water has a like effect; cold, or the pain from a needle prick, a less. Sound, light, taste, and smell stimuli act similarly. If the eyes have been closed some time, mere opening of them causes a considerable deflection from the skin of the hand. Different colors here acted unequally. It is remarkable that these skin currents also arise when the sensations are merely imagined.



AN ARTIST WITHOUT ARMS.

THE PARIS EXHIBITION. CENTRAL STATION OF THE EDISON COMPANY.



One vividly imagines, *e. g.*, he is suffering intense heat, and a strong current occurs, which goes down when the idea of cold is substituted. Mental effort produces currents varying with its amount. Thus, multiplication of small figures gives hardly any current; that of large, a strong one. If a person is in tense expectation, the galvanometer mirror makes irregular oscillations. When the electrodes are on hand or arm, a voluntary movement, such as contraction of a toe or convergence of the eyes, gives a strong current. In all the experiments it appeared that, with equal nerve excitation, the strength of the skin currents depended on the degree to which the part of the skin bearing the electrodes was furnished with sweat glands. Thus some parts of the back, and upper leg and arm, having few of these, gave hardly any current. Herr Tarchenoff considers that the course of nearly every kind of nerve activity is accompanied by increased action of the skin glands. Every nerve function, it is known, causes a rise of temperature, and accumulation of the products of exchange of material in the body. Increase of sweat excretion favors cooling, and the getting rid of those products.

THE PARIS EXHIBITION—THE CENTRAL STATION OF THE COMPAGNIE CONTINENTALE EDISON.

SINCE its formation in the year 1881, during the International Electrical Exhibition in Paris, the Compagnie Continentale Edison has carried out some very important installations of electric light on the Continent and in the provinces and capital of France. Among those in operation in the city of Paris the most remarkable are doubtless that of the Grand Opera, with over 7,000 lamps, and that of the Palais Royal, with 1,200 horse power and subterranean mains for 20,000 lamps.

These installations—which, by the courtesy of the company, have recently been visited by English electricians and engineers—are familiar to many, but it will bear mention that the Palais Royal station partakes more of the nature of a central station laid down on the most modern lines adopted by the company. For instance, in addition to the lighting of the buildings and theater of the Palais, a circuit of arc lamps in the Place du Carrousel is run from the same station, and for longer distance circuits an alternating transformer system is in operation. The lighting of the Elysee for the President of the Republic by means of 2,000 lamps, and a portion of the lighting of the Palais de l'Industrie for the Centenary series of fetes, has been effected by this system, operated by two Zipernowsky dynamos of 84,000 watts and a concentric cable system of underground conductors. Further, the work of lighting the important district of the city granted by the concession made to the company as recently as December, 1888, was set on foot in March of the last year, and the most prominent portion of the district, viz., the boulevards from the Opera to the Porte St. Denis, lighted from the 1st of June.

This system of distribution in the city, supplying arc lamps along the streets, and incandescent lamps to private consumers along the route, is of special interest. The three-wire system is used, and the main conductors of bare copper are laid on porcelain insulators fixed to the sides of a culvert of masonry and cement built beneath the pathway. The system is fed by the central station in the Faubourg Montmartre, which, when complete, will contain a plant of some 1,500 horse power.

The central lighting station at the exhibition was intended to embody the most modern applications introduced as the result of the experience gained, and as such presents many points of special interest. The building and the placing of the machinery and boilers was planned by Mons. Vernes in conjunction with MM. Weyher and Richemond, who supplied the engines, and the Belleville firm supplying the boilers. Viewed in every respect the station presents a fine appearance, and is an admirable piece of central station engineering. The perspective illustration of the station indicates the general position of the dynamos and engine. In the center of the station are erected four 160 horse power vertical triple expansion condensing high speed engines by MM. Weyher and Richemond, of Pantin, Paris.

The engine seen on the right in the view of the station drives directly by belting an Edison dynamo of 100,000 watts capacity at 350 revolutions. Behind this another engine drives a similar dynamo, and on the left a similar engine drives two 55,000 watt dynamos. To the back of this again a fourth engine drives two more 55,000 watt dynamos. A fifth engine, compound vertical condensing, of the same power, drives two more 55,000 watt dynamos by tandem belting, these machines being indicated on the left of the view. The station, therefore, is equipped with a plant of 800 horse power, which is utilized in supplying 6,773 incandescent lamps, 170 arc lamps, and in furnishing current to various exhibitors for the running of motors and charging of accumulators. Steam is produced by three Belleville water tube boilers, each of which is capable of delivering 5,700 lb. of steam per hour at a pressure of 12 atmospheres. Two of these generally suffice for the evening's run, the other being in reserve.

The dynamos in the central station at the exhibition are of the two largest types in this series, and all the machines are wound to 110 volts, so that they may be used together in parallel on the three-wire system of distribution. The No. 7 machine, of 55,000 watts, is constructed with two vertical field limbs of wrought iron, the pole pieces and armature being below. The form of the field is much more compact than the original Edison machines, the advantage of this having now been well ascertained. The weight of the machine is a little over 5½ tons, and it is driven at 650 revolutions. All shunt dynamos now, from 2,000 watts upward, of this series, are of the same construction.

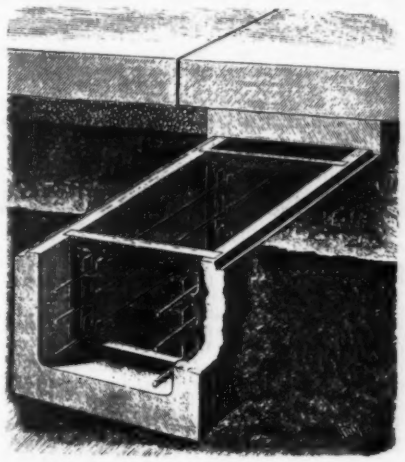
The No. 8 machine is built with eight field magnet limbs of wrought iron, the pole pieces and armature being in the center. The gross weight of the machine is 11 tons 15 cwt., speed 350 revolutions, and output 100,000 watts. Attached to the machine is a rapid break switch. A horizontal handle is pulled down to close the circuit, forcing a movable copper bar over the two terminal contact blocks, and in so doing compressing a strong spring. When contact is made, the vertical handle is closed on the switch, engaging into it and keeping it in its closed position. When released, to break circuit, the compressed spring causes the copper bar to fly off suddenly and prevent an arc forming.

These dynamos have recently been submitted to dynamometer trials to ascertain their industrial efficiency, in view of the standard required by the city of Paris to be guaranteed upon all dynamos supplied to the municipal central station at the Halles Centrales. The results showed that the ratio of the electrical power available in the external circuit to the mechanical driving power on the dynamo pulley reached as high as from 91 to 93 per cent., according to the dimensions of the machine. The armature shafts are of steel; the bearings of phosphor bronze, and the lubrication of the same is automatic, by means of rings surrounding the shaft and dipping into oil wells. The brush holders in use on these machines are shown in Fig. 1, the brushes themselves being composed of copper wires massed together. Heavy insulated cables lead the main current from the brushes to the apparatus for coupling and grouping the machines, and wires are also brought from the shunt field of each machine to this apparatus, where the resistance in each field can be regulated. Of this ingenious piece of apparatus we are pleased to be able, through the courtesy of Mons. Vernes, the Administrateur-Delegue, to furnish some particulars of its construction and action.

The Edison three-wire system of distribution works at its highest efficiency for a given lamp supply when the two external mains carry the same current. The two dynamos then act together in series, and the given lamp load is divided into two equal sets working in series, and at exactly the same potential. In wiring a district on this system the lamps are as much as possible distributed equally on each "bridge," taking into account the number of lamps and duration of lighting. The equality, however, cannot constantly be maintained, and some system of regulation to effect as near an approximation to it as possible must be adopted. The Edison Continental Company effects this regulation in the first place by dividing up the total lamp load into a certain number of distinct three-wire circuits, radiating from the central station and controlled therefrom; and secondly, by an apparatus for changing the number and grouping of the dynamos on either bridge, according to the load of each.—*The Engineer.*

ELECTRIC SUBWAYS AND CABLES IN PARIS.

PARIS has lately introduced an electric lighting system for use in the various great markets of that city. The installation includes the Edison and Ferranti dynamos and the Edison distribution, and is fully described in *Le Genie Civil* of Nov. 30.



PARIS SUBWAY FOR ELECTRIC LIGHT WIRES.

An interesting feature is the subway adopted and here illustrated. It is placed under the pavements, as it was believed that the sewers were too damp for the successful working of the system. This dampness was likely to produce disturbing induction between the electric light and telephone cables, and they would be further exposed to careless or malicious handling by the many workmen circulating through these sewers.

As shown, the cables are placed immediately under the paving slabs in moulded cement channels, about 10×12 in. inside measurement, and covered with cement blocks. About every 5 ft. wooden frames hold cast glass hooks which supports the cables. Under the streets, where the soil is more damp and permeable, and where the charge is heavier, the cables are placed about 3½ ft. below the surface. At each angle of a street intersection a connecting well establishes communication between the street and pavement subway.

The cables are made of wires of galvanized copper of a number and diameter varying with the location. These wires are twisted together and covered with a coating of pure rubber; around this again is two millimeters in thickness of a rubber compound, and about the whole are wrapped two ribbons of cotton dipped in rubber. This whole cable is vulcanized into a compact mass, and finally covered with a strong twist of hemp dipped in resin, tar, or bitumen.

The section of the exterior system of cables is given as follows:

Feeders.	Extreme wires.	Neuter wires.
1	80 mm. sq.	40 mm. sq.
2	120 "	80 "
3	80 "	40 "
4	100 "	80 "
5	120 "	60 "
Distribution circuit Uniform section	40 mm.	20 mm.

These cables have been calculated for a mean density of 2 amperes per sq. mm., and for a fall of potential of 10 volts. The reistance of insulation is figured at 300 megohms per kilometer, at 24° Cent.

In certain parts of the city it was necessary to put the cables in the sewers; and to prevent disturbance of other currents, recourse was had to concentric cables made as follows:

A core of 19 copper wires of 2 mm. made a section of 60 sq. mm. These were galvanized and twisted and covered: (1) With two coats of pure rubber 1 mm. thick in all; (2) by several coats of vulcanized rubber 8 mm. thick in total; (3) by two ribbons soaked in rubber and rolled in opposite directions. A series of copper wires rolled in a spiral about the first formed a second circuit, having the same section, and this compound cable was then covered: (1) With two coats of pure rubber; (2) with several coats of vulcanized rubber 3 mm. in total thickness: (3) with two rubber dipped ribbons rolled in the opposite direction; (4) with a covering of hemp dipped in a resinous composition, 3 mm. thick; (5) two ribbons of woven cotton coated. This whole cable was finally inclosed in a leaden pipe 2·5 mm. thick, covered with a strong net of fiber dipped in a bituminous compound.

These cables are supported on wooden rests built into the sewer masonry. The resistance of insulation is figured at 1,500 to 3,000 megohms per kilometer of cable. —*Engineering News.*

THE ELECTRIFICATION OF A STEAM JET.

AT a recent meeting of the Physical Society, London, Mr. S. Bidwell read a paper on the above subject, illustrated by some beautiful and striking experiments. The jet was obtained from a small boiler, formed out of a tin canister, into the neck of which a cork was fitted, and this cork was traversed by a tube bent at right angles, and terminating in a nozzle. The object of bending the tube in this manner is to avoid having the flame used for boiling the water in the boiler immediately under the steam jet, as the effect would then be to dissipate its charge of electricity.

It is desirable that the glass tube should be as free from water as possible, and therefore it should be of comparatively large diameter. The tube employed in the experiments shown to the society was $\frac{1}{4}$ of an inch in diameter, and the nozzle at its extremity $\frac{1}{16}$ of an inch in diameter. Some four ounces of water were introduced into the small boiler, and heated until a strong but steady steam jet was seen to issue from the nozzle (if the ebullition is too violent, the water thrown up into the tube will produce unsteadiness); the image of the steam jet was then thrown upon a screen by means of a projecting lantern, and was seen to be of feeble intensity and of a neutral color, being in fact nearly transparent, and appearing to exert little or no selective absorption upon the beam of light transmitted through it.

A small bundle of needles in connection with one of the terminals of an influence machine was then brought near to the base of the jet, and the machine was slowly worked. The image of the jet instantly became dark and dense, and assumed a marked orange brown tint, but instantly returned to its original condition when the electrified points were removed or earth connected.

It is not necessary for the points to be directed to the origin of the jet, as they are nearly as effective when placed in the steam at a distance of a foot from the nozzle, the whole of the steam jet, from the nozzle upward, being acted upon just as before. If a ball is used instead of a point, a similar result is obtained when the ball is actually within the jet, but not otherwise. Similar results may be obtained by directing the jet upon an electrified metal disk, which may be at a considerable distance from the nozzle.

The author stated that he had examined the absorption spectrum of the steam jet, and had found that, when unelectrified, the jet had very little action upon the spectrum, its total effect being merely to slightly diminish the brightness of the latter, the diminution appearing to be of equal intensity throughout, though he thought it possible that the violet might be dimmed slightly more than the other colors. Electrification was found to cause a total disappearance of the violet, and, at the same time, the luminosity of the blue and the more refrangible part of the green was decidedly diminished. The orange and red did not appear to be affected.

The author concludes from these observations that the effect of electrification is to cause an increase in the size of the water particles contained in the steam jet. When the jet is unelectrified, most of these particles are small compared with the wave length of light, but when electrified, their diameter may be something like $\frac{1}{10000}$ of an inch.

It seems natural to suppose that the phenomenon was analogous to an experimental result obtained by Lord Rayleigh, in which a stream of water issuing almost vertically from a small orifice was found to break up into small drops at a certain distance above the orifice; and while under ordinary circumstances these drops collide with one another and become scattered over a considerable space, when an electrified body, such as a rubbed stick of sealing wax, is brought near the point at which discontinuity begins, the drops no longer rebound, but coalesce, and the entire stream of water, both ascending and descending, appears to become adherent.

The author observes that in the case of the steam jet the minute particles of water, each consisting of minute molecules, must necessarily collide frequently with each other, and therefore it would seem that they ought to behave in the same manner as the larger drops when electrified. The fact that a much higher degree of electrification is required to produce the effect in the case of the steam jet, rubbed sealing wax being quite inoperative, scarcely seems to agree with this explanation; but the author suggests that the difference may possibly be due to the different sizes of the drops in the two cases, and in support of this he adduces the fact that if two electrified steam clouds are generated in close proximity to each other, they exhibit little, if any, mutual action: so that the electrification of the water particles must really be extremely small.

Lord Rayleigh shows cause for believing that if the drops in the water jet were all equally charged, the phenomenon would not occur; and to whatever cause this inequality may be due, it would probably be equally effective in the case of the steam jet. Lord Rayleigh has not suggested any explanation of the manner in which unequal charges of electricity of the same sign could bring about coalescence, and the author has not any suggestions of his own to make on the matter.

Lord Rayleigh, in a paper describing this phe-

nomenon, points out its importance in connection with meteorological phenomena, and the author suggests that his own experiments with the steam jet appear to suggest an explanation of the intense darkness characteristic of thunder clouds, and also of the lurid yellow light by which their darkness is often tempered.

In concluding the account of his own experiments, the author stated that subsequent to their completion, and to his having offered the paper to the Physical Society, Professor S. P. Thompson had called his attention to a paper by the late R. Von Helmholtz (Wiedemann's *Annalen*, vol. xxxii., p. 1), describing experiments made by him upon the electrification of a steam jet. Helmholtz did not appear to have examined his jets by transmitted light, and made no mention of the great increase of opacity under electrification.

In his experiments the jet was invariably observed against a dark background, illuminated by a ray of light coming obliquely from the front and shaded from the eyes. He found that when the jet was electrified, it was seen much more clearly and sharply defined against the background; and diffraction colors, similar to those seen in fog strata, were exhibited. When the jet was very strongly electrified, a deep blue color was produced, showing that very small mist drops were formed. When the electrification was slowly diminished, the blue tint became gradually paler, indicating the formation of larger drops, and this was succeeded by tints of purple, red, yellow, green, and ultimately, when the discharge became very feeble, pale blue again. Under certain circumstances all these different tints could be observed simultaneously in different portions of the jet.

The author stated that he had observed these diffraction colors in his own experiments, but he did not follow up the observations, as he found that they occurred when no electrical influence known to him was operating.

Helmholtz found that these condensation phenomena could be produced equally well by causes other than electricity, more particularly by the aid of flame. All the causes in question involved some continuous chemical action within the steam jet, and he therefore thought the sudden condensation might be ascribed to molecular shocks upsetting the equilibrium of the supersaturated vapor, in very much the same way that a supersaturated saline solution can be made to crystallize by a slight disturbance.

The author then illustrated the effect of combustion by holding a piece of burning touch paper, made by soaking blotting paper in a solution of nitrate of lead, underneath the jet, it being impossible to employ a flame, as it would discharge the electrification of the jet. It was immediately electrified in exactly the same manner as by electrification. The burning touch paper appeared more convenient than the flame employed by Helmholtz, as it would be impossible to place the latter under the jet without dissipating it, and it would, therefore, be necessary to hold it on one side and blow the heated gases on to the jet.

The experiments described in Helmholtz's paper naturally suggested to the author to try the effect of combustion on the water jet, in which case, of course, the objection to the use of a flame did not apply. A Bunsen flame was therefore introduced into the jet, and it was found that when the air holes of the Bunsen burner were stopped up, so as to make the flame luminous, the effect was generally similar to that of electricity, but was not obtained with the same perfect certainty; but when the burner was held a little below the point of resolution, a great diminution of the scattering was invaviably observed.

The non-luminous flame had no effect whatever upon the jet. The author suggested that the effect of the luminous flame might possibly be due to its being electrified, as it is well known that luminous flames are electrified, in illustration of which he placed a luminous gas flame between the points of a Voss influence machine in action, the terminals being so far apart as to prevent sparks from passing, and it was observed that the upper part of the flame was repelled by the positive and attracted by the negative knob. The author mentioned, in concluding his paper, that Helmholtz had suggested, as an alternative hypothesis to that of molecular shocks, that the electrical discharge of the flame or other exciting agent might possibly act by introducing small particles of solid matter into the steam jet, which particles might act as nuclei upon which the water vapor might condense, as in Aitken's experiments upon the formation of fog.

In the discussion which followed the reading of the paper,

Prof. Rücker inquired whether the author had considered the effect of surface tension upon the flame; for, as he pointed out, the higher the surface tension, the more rapidly would rupture take place. The surface tension would be altered by the action of heat, and perhaps also by the introduction of solid particles, and both these would act in the same way.

Mr. Richardson inquired whether the author had tried the effect of substituting red hot iron instead of a flame, as in that case no solid particles could be introduced.

Prof. Herschel remarked that the silky clouds often observed hanging over volcanoes after an eruption might possibly consist of vapors of sulphurous acid and other substances condensed electrically in this manner.

Dr. Fison stated that in some experiments which he had made with a wire, held at various distances above a Bunsen flame, the greatest amount to which the potential of the wire was raised above that of the earth was about two volts, gradually diminishing as its distance above the flame was increased, until the electrification changed sign and increased negatively to a potential of 1·5 volts. It seemed to him that these charges would be too small to produce the observed effects.

Prof. S. P. Thompson observed that there seemed, according to the author's experiments, to be a curious contrast between steam jets and other clouds. For example, in Dr. Lodge's experiments it was found that fog could be dissipated by electrification. He inquired whether the author had observed the existence of any relation between the amount of change in the color of the jet and the length of the spark.

Mr. Bidwell, in replying, said since writing the paper it had occurred to him that the effect of the flame might possibly be due more to the presence of dirt than to electrification, and, in illustration of this, he pointed out that Lord Rayleigh had found that the experiment did not succeed when the steam was obtained from soapy water. He had not tried the effect of using hot iron in place of flame, but he did not think it would produce any effect. Dr. Fison's observation of the greatest difference of potential obtainable from a flame was in agreement with what had been noticed by other observers, but he did not think the charge was necessarily too small to account for the effects observed when the flame was placed between the terminals of an influence machine, for it must be remembered that though the flame might only be charged to the extent of a couple of volts or so, the difference of potential between the terminals of the machine would amount to some thousands of volts. He had not obtained any definite relation between the color of the jet and the sparking distance; indeed, the color appeared to be unchanged, whatever the length of the sparks, except on one occasion, when he thought he observed a slight tinge of slate color when the sparks were very long, and the machine was turned very rapidly; but he was not able to obtain the result again upon repeating the experiment.

ELECTRICAL ENGINEERING IN AMERICA.

AT the recent meeting of the Institution of Electrical Engineers, London, a paper was read by Mr. G. L. Addenbrooke, on "Electrical Engineering in America," of which we give the following abstract:

The last eighteen months or two years in America have been much more characterized by commercial and industrial progress with already existing types of plant and apparatus than by a number of new inventions. Throughout the continent, from shore to shore, the main thing that forces itself on the observer is the prevalence of arc lighting. Hardly any what we should call moderate-sized village outside the oil region appears to be without its arc lamps. Arc lamps, when used for public lighting, are usually fixed on the poles from 20 ft. to 40 ft. high, according to the caprice of the parties interested in their erection; or they are slung from the corners of intersecting streets, in which case they usually hang low down; or the tower system is adopted.

When posts are used, they are of rough pine, never painted, often out of the straight, and warped or bent. If the lamps are fixed, iron spikes are usually driven at intervals on each side of the pole, starting about 8 ft. from the ground, and forming a sort of ladder by which to reach the lamp. During my whole journey from San Francisco to New York, I can hardly recollect seeing one ship-shape, neat and smart-looking post, whether for carrying arc lamps or for any other electrical purpose. Everything has a temporary and expedient look about it, which is very offensive to English eyes. The lamps themselves are usually very roughly fixed on the poles.

When the lamps are hung over the center of intersecting streets, four wires are brought down from the corners of the neighboring houses, the lamp hangs from the center, and is lowered and raised by a pulley and cord. The wires from which the lamp hangs, the cord and the leads all festoon about in accordance with the chapter of accidents, and look, as we should think, both slipshod and untidy. By using the tower method one's eyes are not dazzled by the brightness of the light, which is so much the case with lamps at a low level. Important, however, as the public lighting is in the large towns, it occupies a comparatively inconspicuous place in comparison with the number of lights used for illuminating stores, saloons, hotels, restaurants, and all sorts of public buildings. Arc lamps are so lavishly used in these places, both inside and out, that the principal streets are often literally a blaze of light. The circuits feeding lamps hung either inside or outside of a building either run direct from the nearest poles on each side of it, thus making an angle over and across the pavement which is very unsightly, or a sort of barrel-shaped glass insulator is used.

This insulator has a hole through the center and a groove round the middle of the outside. The wire coming in one direction is passed through the center of the insulator, turned back on itself, and made off; the wire in the other direction is passed round the outside, and also made off on itself; the two ends of the loop are then carried to the lamp through which the circuit is completed. Nearly all the wire I saw was insulated with "underwriters' insulation."

Where lamps are used internally this is often carried through wooden window frames and other similar places without any further protection or care. Once inside, the wire is carried along ceilings and walls quite exposed, but separated about 3 in. by small wooden cleats. Sometimes instead of cleats small white porcelain insulators are used. As far as I could learn, it is the invariable custom for all companies to run, fix up, and entirely look after the lamps they operate. The customer simply pays a rent for the use of a lighted lamp of so much a week, month, or year, as the case may be, and has no further trouble of any sort. To see that the lamps burn properly, linemen parade the streets all night, and are supposed to see every lamp on their circuits at certain intervals. The circuits themselves are almost invariably carried on poles erected along the edge of the curbstones.

Long wooden cross arms are fixed near the top of the poles, carrying from two to six, and even eight, insulators on each arm, and the weight of the circuits often pulls them out of the horizontal. I must make some exception, however, in the case of the Thomson-Houston Company, in New York, who, at any rate, had got light iron stays attached to the poles and arms at an angle, so as to give more support to the arms and keep them in their places. Green glass insulators are supported on the arms by wooden pegs, which have a screw thread cut on the part that projects. They are very cheap, and answer the purpose well. Still, the effect of green glass insulators on arms painted a dull red, fixed on bare poles from which the bark has just been stripped, is not æsthetic.

On the frequent occasions when it is necessary to go up to the top to make alterations or add new circuits, the linemen use climbing irons. The tearing of the wood by the spikes of these climbing irons gives the poles a jagged and frayed-out appearance from top to bottom.

One could fancy they lead to the habitation of some immense squirrel. Little trouble is taken to keep the various circuits on one pole in regulation with each other, as long as they do not touch. Indeed, the whole construction of the poles and arms is so flimsy that no great strain could be put on the wires. The poles themselves are fixed at short intervals, often not more than thirty yards apart, and seldom above sixty.

Construction work for alternating currents is generally carried out on much the same lines as for arc lighting; the only difference is that in the latter case converters are stuck against the outside of buildings instead of arc lamps, which, of course, are in parallel instead of in series. A rough hole is knocked through the brickwork just under the place where the converter is fixed, for the secondary leads, which are slipped through a couple of rubber tubes and carried inside. But little attempt is usually made to execute this part of the work in what we should call a neat or workmanlike manner. Some of these arc circuits are now used as power circuits in the day time, which forms a source of extra revenue. Simple and crude means were everywhere used to effect in a rough and crude manner the end desired. In the means employed there is little to excite either admiration or interest. The interest lies in the fact that in such a simple and elementary manner so much has been done.

As far as I could ascertain the various systems of conduits have not proved very successful so far, and the fact that the Subway Company in New York are, I believe, laying down iron pipes entirely—at least, they were in every place I saw work going on—points to this conclusion. The system of construction for underground work at present being carried out in New York is as follows: Manholes at convenient distances are made in the roadway—not, as a rule, in the pavement, but just on the rise of the road, and clear of the gutter. These manholes are circular, and covered by a heavy iron lid. Below the manhole is a bell-shaped pit 8 ft. or 9 ft. deep, bricked round, and of sufficient size at the bottom for a couple of men to stand fairly comfortably to work.

Iron pipes, such as are used for water or gas, are laid in the ground from one manhole to the next. I understand that each electric company will, as a rule, have a separate pipe, so that if there are several companies running along the street, they will each require a separate line of piping opening into the manhole. There will, therefore, often be several pipes entering at each side of the manhole. These pipes enter the manhole at such a height as, roughly, to come between the hips and breast of a man standing on the bottom—at a height, in fact, to bring them in a fairly convenient position for working. The cables are drawn through the iron pipes in the ordinary way. Branches are taken from the manholes under the roadway and pavement to any house between the manholes requiring current. The conductor consists of seven strands of No. 16 copper. These are insulated by a layer of a hard but somewhat flexible material, containing, I believe, some rubber in conjunction with other materials, but the complete material is cheaper than the rubber used alone.

The thickness of this material surrounding the conductors is one-twelfth of an inch. It somewhat resembles ebonite, and is of a consistency to stand rough usage and hard wear. The insulating material is covered with a lead pipe about one-sixteenth of an inch thick, and containing, I believe, a percentage of tin. Coming now for a moment to the internal work in buildings, most of what I saw had a rough, temporary look about it, evidently being put up as cheaply as possible. Turning aside for a moment, it appears to me that one of the great wants all over the world now is, if I may so term it, a "science of illumination." Up to and as far as *providing* light, we are exceedingly scientific. But in *utilizing* it when we have got it, we proceed in an elementary and haphazard manner. Coming now to central stations, those I went over were the new Arc Light Station in San Francisco, the Edison Station in Chicago, the Westinghouse Station in Pittsburg, and the Thomson-Houston Station in New York. The station in San Francisco is near the railway station. It is about 250 ft. long by 80 ft. broad, with a ground and two upper floors, and has been finished about eight months.

It is intended to provide accommodation for about 2,000 arc lights when filled up. At present it is furnishing current for about 600. It is arranged in the usual —I was going to say invariable—American plan of placing the engines and boilers on the ground floor, and arranging the dynamos, switch-boards, and electrical portion of the station on the first floor. In this instance the second floor is used as a storehouse and for general purposes. It is arranged for two lines of boilers, one on each side. They face toward the center of the building, with a large space between for coals and general working purposes. The boilers were of the well-known water-tube pattern. This type, varied slightly in detail by each maker, seems to be in general use everywhere in the States. From the boilers the steam is led to a 650 horse power single cylinder Corliss engine, which, by rope gearing, drives a single line of countershafting. The working of the station was dependent on the single engine and line of shafting keeping in good order. At San Francisco the motor business is steadily increasing. The next station I visited was that of the Westinghouse Company at Pittsburg.

It is situated in a large building of the warehouse type, quite in the center of the town. The boilers here are of the water-tube type, but heated by natural gas instead of coal. This natural gas is brought in pipes to the town from a distance of thirty-five miles. The company who own the line of piping—of which, by the way, Mr. George Westinghouse is also president—sell this gas to manufactories, etc., at a rate which is nearly equivalent to the cost of coal; so that, although the convenience is great in using it, the economy is not so large as might at first be anticipated.

Work at the Pittsburg station was in the first instance begun with two Corliss single cylinder engines of the ordinary type, driving on to a line of countershafting; but this method of working has not been extended, and some of these engines have since been removed. The next additions to the station consisted of Westinghouse Standard engines of 250 indicated horse power, driving 2,500 light alternating dynamos. These engines stand on square blocks of concrete and masonry; the blocks for this sized engine are about 7 ft. by 5 ft. The last additions are of the new type of Westinghouse compound engine. From a power point of view, as well as from an electric point of view, the station has therefore something of historical interest. The Standard type has now stood the test of several

years' work very satisfactorily, and there is no room to doubt that the compound engine, constructed in the same shops and by the same method as the Standard engine, will wear at least as well.

The makers' tests show exceedingly good results for this compound engine, viz., from 18¼ lb. to 19¼ lb. of water per brake horse power hour with condenser, and from 24 lb. to 25½ lb. without condenser. I feel perfectly confident that the figures given by the makers are thoroughly reliable. Five Westinghouse engines of 250 indicated horse power drive five alternating current dynamos of 2,500 16 candle power lights capacity each, besides the machine driven from the Corliss engine. The exciters are run from smaller engines. The engines driving the alternating dynamos make 250 revolutions per minute.

The power is conveyed overhead by belts to the first floor, where the dynamos are placed. Each of these dynamos is on a sliding bed, so that the belt can be tightened; and as I have already said, the exciters are run separately from the machines. One exciter is used for several machines; each exciter has a resistance in its field magnets which can be varied. There is, moreover, a separate resistance in the field magnet circuit of each alternating machine, so that the e. m. f. of the machine can be varied while its speed remains constant.

I did not hear or see much of the method of running two separate machines parallel on the same circuit. Whatever may be done in isolated instances, it does not appear to be practiced generally. Indeed, with the American system of running a number of small circuits instead of fewer heavy ones, the desirability of doing so does not often come in. The Westinghouse company also use a piece of apparatus containing an adjustable converter, which enables them to supply current from the same machine to two feeders having a different fall of potential. The Thomson-Houston station in New York is neither so large nor so well arranged as their station in Brooklyn, which I had not time to see. The engine—and there is only one—which furnishes power to this station is a large compound condensing Corliss engine, two cylinders being in tandem. The principle of leaving the working parts of high tension alternating current switch-boards exposed is not confined to American manufacturers. A good deal of the Continent work is even worse.

Such very full accounts have been published of everything that has been done in electrical tramways that there is really little I can add to them. The total mileage, so far, is 1,260 miles, with 1,884 cars, on 179 roads. Of this, 716 miles were, it appears, actually being operated by electricity at the date of the return, and 544 miles were under contract. Of this total, 21 miles were worked by cars with storage batteries, and all the rest, with the exception of two or three miles, by overhead conductors. The companies claim a reduction of 50 per cent. in the cost of working over the employment of horses, putting aside all the extra facilities.

In the discussion which followed:

Professor Forbes indorsed the account of American electrical engineering, particularly as regards the rough and ready way in which the work is usually carried out, but thought the more solid construction adopted by English engineers would prove better in the long run. Speaking of American factories, Professor Forbes said that great attention was paid to testing, and as a result the efficiency of converters had been considerably increased.

Mr. H. C. Donovan considered that the apparent disregard of insulation was to be attributed to the dryness of the climate.

Mr. W. P. Granville said the usual method of specifying insulation resistance of cables, viz., in megohms per mile, was unsatisfactory, and that the diameter of the conductor should be taken into account, and that tests of lead-covered cable should be made before sheathing, and while the cable is immersed in water.

Professor S. P. Thompson had hoped to hear that in the five years since he visited the States improved methods of wiring, etc., would have been adopted, but no great change seemed to have taken place. After making inquiries as to the kind of meter used on the constant current arc circuits, Dr. Thompson expressed his opinion that the alleged greater steadiness of American arc lights was due to the greater personal pride which the attendants have in the particular system with which they are connected.

Mr. Swinburne thought the system adopted in American business, where the perfecting of designs and the experimental work are kept quite distinct from the wholesale manufacturing parts, better than ours. Referring to Mr. Granville's contention, he said that instead of insulation resistances being given in megohms per mile, they should be expressed in megohm miles for each size of conductor.

The president, while deprecating imperfect work in general, thought it advisable that English electricians should acquire whatever good could be got from the "rough-and-ready" methods adopted in America, and considered that progress might be retarded by waiting too long to attain perfection.

Replying, Mr Addenbrooke said he agreed with Professor Forbes about the way in which testing is appreciated, and with Professor Thompson as regards the interest which the men take in their work; the latter fact Mr. Addenbrooke attributed to better wages and greater chances of promotion.

CAUSES OF INSUFFICIENT STRENGTH IN WOOLEN GOODS.

By K. L., in *Das Deutsche Wollen-Gewerbe*.

THE woolen goods manufacturer has to contend with various disadvantages, which occasionally must cause him to lose much of his zeal in the manufacturing business. He naturally blames his assistants, who have to bear a large share of the responsibility for poor work. One of these drawbacks is the constantly increasing complaint about the insufficient strength of the cloth, and in order to grapple with this vexed question in an intelligent manner, it is necessary that the mill officials should give their undivided attention to ascertaining the source of the trouble.

Let us first inquire how it happens that, especially of late, the want of strength in cloths is becoming so noticeable, to such an extent, indeed, that it almost seems as if the manufacturers of our day no longer understood how to produce as strong a fabric as formerly. It is well known that the goods manufactured by former generations were stronger and wore better, for the simple reason that manufacturers in those days, as a rule, had a better quality of wool than now. Again, they were in ignorance of the uses of wool substitutes, mungo, shoddy, etc., nor did they understand anything about the fulling on of flocks.

If may be added that cloth consumers, in the good old times, did not demand so much as the swells of the present generation, and they were not so particular about the finish of the cloth. They were not then acquainted with that bane of the manufacturer, the dynamometer, and it is, therefore, highly probable that many a piece of cloth of inferior strength and quality slipped through with the better grades. No instructions as to a required strength expressed in kilogrammes could, at that time, be given by commission houses, while, at present, it is fair to presume that purchasers will sometimes make unreasonable demands concerning the weight of goods.

Instances are not, by any means, rare where smooth faced goods without a back, and of a weight of from 800 to 900 grammes [1 kilogramme = 1,000 grammes = 2 lb. 3¼ oz.], are demanded, while, at the same time, the face is to be smooth and close, and of the best style of finish. It is not our intention to contend for, or against, the use of the dynamometer, although it is proved that it shows frequent deviations after several experiments with the same piece of cloth.

Still, on the whole, it cannot be denied that the instrument has its advantages, chief of which is that it protects the conscientious manufacturer against fradulent competition by means of imitations. Various causes are attributed for the want of strength in that class of goods manufactured from wool as distinguished from worsteds.

These causes may be separated into two categories, those due to insufficiency of the raw material itself and those due to improper treatment in the manufacture of the cloth. We will begin with the former. A large portion of the raw wool material of the present day leaves much to be desired. It is well known that the rearing of the fleece, a product formerly tended with the utmost care for the manufacture of cloth, is now greatly neglected.

The breeding, feeding, and care of the sheep differ much from that of the former times. Even the treatment of the fleece before it reaches the hands of the manufacturer is not the same. The trouble of assorting the fleece carefully, according to the various parts of the body from which it was sheared, or the quality of the staple, is now usually dispensed with.

The wool of each animal varies largely in strength and capacity of felting, according to the part of the body where it grew. Transatlantic wool, much of which is more carelessly raised than the domestic product, and maltreated in foreign wool-scouring establishments, is not likely to be any stronger than our home wool.

Much is to be expected of the Cape wool, on account of its strong staple and curling capacity, but, in this brand, as well as in the inferior grades, the defective lots increase from year to year. It is well known that many sheep breeders at the Cape, when they are in want of money, have their sheep shorn twice or three times a year, regardless of the season. On the other hand, it cannot be said that the large percentage of wool substitutes added to the clean wool is calculated to increase the strength of the cloth. In order to manufacture a good fabric, which shall comply with fair demands as to strength and quality, a sound and strong wool is first of all indispensable. The strength of a cloth is not alone due to the felting in the milling operation, although it may be an essential factor.

The strength of the staple is a fundamental condition, and is fully as important a factor as its capacity for felting. Various kinds of wool full and felt very well, but it cannot be said that the strength of the cloth is materially increased thereby. Even under the most careful and rational manner of treatment, wool fiber suffers to a certain extent in the various processes of manufacture, and, for this reason, it becomes necessary, in order to produce a strong cloth, to use a staple of the highest degree of strength, so as to withstand the wear and tear of manufacture.

Accordingly the manufacturer or the superintendent of a woolen mill should possess a sufficient knowledge of wools, based upon practical experience, to enable him in the choice of the material, besides judging of its fineness, to sample its strength for certain grades of goods. Although the most careful treatment of the wool or the goods in the process of manufacture cannot supply the want of natural strength of the staple, yet, on the other hand, a careless and improper treatment may rob the strongest staple of its natural qualities and strength.

The initial operations of the manufacturing process, the washing, scouring, dyeing, drying, etc., are frequently the first cause of the weakening of the fiber. Too strong a lye in proportion to the quality and composition of the yolk, too high a degree of temperature in the scouring bath, or both together, impair the staple, make its surface spongy, injure its natural strength, and deteriorate its felting capacity, by loosening and stripping off the horny serrature so necessary for the latter.

The entangling and felting in the scouring and washing operations are also to be avoided as much as possible, because felted fibers, instead of being separated and laid parallel, in the opening and carding processes, are simply torn into pieces in consequence of their matted condition. Another matter which must be duly considered as an important factor in the strength of wool, but which does not generally receive the attention it merits, is the degree of cleanliness of the wool.

Cleanly washed wool dyes better, and, at the same time, does not require to be kept long in the dye kettle. It cards and spins better than unclean wool, the cloth manufactured from it fulls better, and takes a finer finish more easily. Although the assertion of some theorists that the yolk residue still adhering to the staple protects it against any injurious effects of boiling, mordanting, and the dye baths, may appear plausible at first glance, it may be accepted as well established by practical experience that badly washed wool, in spite of these residues, suffers more in the baths than the clean staple.

It appears that, by the action of the mordanting baths, as well as of the chemicals and dye stuffs used, the yolk is partly decomposed, and the ingredients attack the fibers. Practical men understand well the difficulty of spinning wool which contains yolk, now loaded with the residues from the last dye bath. It gums up the card clothing in the first place. Then the fuller knows that cloth manufactured from unclean wool felts with difficulty, because the still adhering yolk and dirt clog up the serratures of the surface, and thereby partly prevent the felting.

It needs no further demonstration to prove that defects such as these must weaken the strength of the cloth. In dyeing, the wool can easily be injured by careless or improper treatment. This operation is the most critical stage in the whole process of manufacture, and it is no exaggeration to assert that, in the majority of cases, want of strength in cloth has had its origin in the dyehouse.

The use of strong or unsuitable mordants, boiling too long or too violently, defective heating arrangements, where the dye kettle and vats are heated more on one side than on the other, are all factors that contribute to impair the structure and strength of the staple. Crowding the dye kettle with wool is another common error that does much harm. The wool is pressed together and cannot be handled.

It is overheated, the temperature within the mass being always greater than at the surface exposed to the dye liquor. The dyer should load the kettle only with so much material as can be handled conveniently. It should move freely in the bath at all times. Diligent handling and turning contribute to equally distribute both mordant and dye stuff, and keep the wool from lodging against the heated sides of the kettle. Especial care should be taken in cooling the wool after it has been withdrawn from the bath. There should be a room large enough for the wool to be spread out in a thin layer, and turned repeatedly. This must be done as quickly as possible, and the wool should not be packed into baskets or barrels until it is thoroughly cold.

The statement is made that want of strength is especially noticeable in brown and dark colored cloths, and that the lots of wool used for these colors suffered more than any others in the dyehouse. It is the browns with their various mordanting and dyeing processes that require the greatest attention from the dyers in order to prevent the wool from being ruined. Every carder and spinner knows that brown wool generally cards and spins badly, every weaver knows that brown yarn breaks very easily, and every fuller knows that brown cloth usually fulls with difficulty. It is well known that kettle colors as a class, even with the most careful treatment, attack wool more readily than vat colors. Lack of strength in white and vat blue goods, other conditions being equal, is comparatively rare. It is necessary, therefore, to use stronger grades of wool for those colors, and to be very careful in handling them when dyeing. The drying of the wool has no material effect upon the strength of the cloth. However, as wool dried in strong heat and insufficient ventilation becomes harsh and brittle, and breaks easily in the carding process, and requires more oil for lubricating, a gentle drying with plenty of ventilation is to be recommended. The oiling or lubricating of the wool before being carded is for the purpose of restoring its softness and pliability, which are partly lost by the washing and dyeing processes.

It is obvious that wool dyed in the kettle must be abundantly lubricated, because it becomes so brittle during this operation. In other words, such wool requires more and a better oil than either undyed wool or that dyed at a low temperature (vat blue). It is the aim of the carding process to preserve the natural length of the staple and to lay it parallel, and not to tear it. This would occur if the material were insufficiently oiled. In proportion as the wool is torn in carding, the strength of the goods suffers. Insufficient oiling, or the use of an oil mixed with substitutes, such as semen psilli, coragheen, etc., in larger or smaller quantities, is always at the expense of the strength of the cloth, and a useless economy.

Opening and carding wool in a moist condition also exerts an injurious influence upon it. The wood fiber when wet is not so strong as when it is dry. A cloth which, when dry, could not be torn, will easily yield in a wet or even a moist condition. For this reason, wet or moist wool is torn much more in carding than when it is dry. Nor will wet wool absorb the lubricant as readily as dry. Naturally strong wool, scoured well, not felted, properly dried, and lubricated with good oil, will pass unimpaired through the carding process and come out all right. In the carding, two points which may exert an influence on the strength of the cloth are to be considered. The first is the position of the workers to each other and to the cylinder; and the second, the condition of the card clothing. If the rollers are too close, the material, instead of being well carded, is torn and chopped. When they stand too open, the wool is insufficiently carded and remains partly unopened, which will always have a bad effect upon the felting and therefore upon the strength of the cloth. Faulty carding also occurs when the clothing is either in a bad condition or it is not cleaned often enough. Frequent and thorough cleaning of the cards is essential in order to obtain well carded wool. After the carding and preparation of the sliver, we enter the spinning room, and find that the twist of yarn is an important factor affecting the strength of the cloth. It is obvious that, with the number of twists and the thickness of the yarn, the strength of the latter increases, although this does not always favor the strength of the cloth. The quantity of the twist in the yarn, especially for the filling, depends always upon the character of the cloth and the pattern to be produced. While filling with open twist for napped goods produces a heavy, close face, hard-twisted filling gives an empty, open face. In the case of warp yarn, which receives more twist than the filling, the quantity of the twist is limited by the subsequent operations of fulling and finishing.

It must be borne in mind that increasing the twist of the yarn decreases its fulling capacity, because more fiber ends are twisted into the interior of the thread, and they cannot interlock so easily. To obtain a satisfactory filling—interlocking—of the single fibers, a certain degree of free movement is required. They must be able to slide into and entwine with each other. Too hard a twist of the yarn renders this diffi-

cult. Therefore, what is gained by the greater twist of the yarn is lost in the impaired capacity for felting of the cloth. For this reason, it sometimes happens that cloth in the warp is hardly any stronger, and perhaps not so strong, as in the filling, despite the greater twist of the former. The closeness of the warp in weaving is, of course, a prominent factor. It must be of such a nature that the weave in the two directions (length and breadth) obtains sufficient closure. If, for instance, it was desired to use a cleanly spun warp, but drawn in wide, the weave would then be nicely closed in the direction of breadth, and be sufficiently strong. In the direction of the warp, however, both these qualities would be lacking. In order to equalize the difference, either more warp must be placed in or else the ends must be thicker. This would increase the closure and strength in the direction of the warp, but decrease it in the filling, since the space then occupied by the heavier warp, either in number of ends or their greater thickness, is not filled by the filling, in consequence of which, less of it can be shot in. In the reverse case, when there is want of closure and strength in the direction of filling, and an increase in that of the warp, the space required for the warp is deducted from the filling, whereby the latter cannot be shot in as close as the weave requires. The weave would be much less close in the filling than that in the warp, so that the low number of picks would not be sufficient to give the weave in this direction the desired strength. In this particular also the fulling has to be considered. An overcrowding of the weave with yarn, either in the warp or in the filling, would require a longer time of fulling, and, under certain circumstances, so much longer that the cloth would thereby be damaged in the milling. The consideration of this point is of the utmost importance to the cloth manufacturer. The closeness and proportion of warp and filling, the run of yarn and proportions of crossing, the spinning and fulling capacity, as well as the strength of the raw material, are all matters which require great knowledge and practical experience on the part of the manufacturer. No definite rules can be established concerning these points, in view of the widely varying factors controlling each case. Especial attention is called to the fact that in each satin weave the warp dominates; in consequence of this, the filling may consist of an inferior material, but its staple must never be short, as the strength in the direction of breadth depends upon it. The essential condition for the manufacturer of a strong cloth is to weave it as well and as closely as possible. A loosely woven cloth will, in spite of the best fulling, never be as strong as one that is closely woven. If due consideration has been paid to the different stages in the manufacture, such as choice of material, its treatment, and the correct proportion between run of yarn, warp, and filling, the fulling process will offer no difficulties, provided the fuller understands his business. The use of unduly strong alkaline solutions in scouring and fulling, as well as fulling too hot, weakens the cloth more or less. It has been remarked previously that alkalies, in strong solution, attack the wool. Strong alkaline solutions impair not only the strength of the staple, but its felting capacity.

The strength of the lyes used for washing and fulling should be carefully ascertained with a hydrometer. The soda lye, the use of which for fulling is now being abandoned, employed for scouring the cloth, should not be more than 3°, at most 3½° B. strong. For cloth from clean wool lubricated with good oil, a lye 2° strong is fully sufficient.

In practice, other factors must also be considered, such as the degree of cleanliness of the wool and the greater or lesser tendency of the lubricant to saponify. Cloth manufactured from dirty wool occasions difficulties in all the stages of the dyeing process, especially in the washing and fulling, in which oil, dirt, and lyes are removed only with difficulty, and then not thoroughly, even by the use of the strongest lyes. In removing inferior oils, unduly strong lye is often necessary. It is not strange, then, that the strength of cloth is so often impaired.

Long-continued fulling causes the cloth to run hot, and often it is fulled for days and subjected to experiments until it becomes soggy and rotten. Too hot fulling also occurs when the fuller does not keep the cloth moist enough. It is also sometimes due to the faulty construction of the fulling machine.

It is frequently observed that a piece of cloth, which is to be tested for its strength, is weaker at the two ends than at all other places. This is unfortunate, for the swatches to be tested are usually cut from the two ends. This, however, is easily explained. The seam, which connects the two ends of the piece, as soon as it enters the rollers of the fulling machine, crowds them apart. Hence they not only receive greater wear, but, by reason of the seam, they do not receive the same quantity of kneading as the other parts, which is so necessary for a good felting. It is advisable, since the seam cannot be dispensed with, not to lap the ends over each other, but to join them end to end, and to use fine sewing thread, to make the seam no thicker than is absolutely necessary. Finally, the cloth may lose its strength by reason of too violent teaseling. It is plain that the loosening and roughening of the felt, even by moderate teaseling, must affect the strength of the cloth, because the closure of the felt, which is loosened almost completely upon the one side, contributes not a little to the strength of the fulled goods. Great care is therefore necessary in this operation, and the finisher must know exactly how deep he can go, without injury to the cloth. A deep teaseling, of course, is sometimes necessary for the production of a soft and elegant nap, so indispensable for the finer grades of goods. Such a cloth should issue strong from the fulling mill, so that, in spite of thorough teaseling, it will still possess sufficient strength. The operator can, by careful treatment and choice of teasels, contribute to the preservation of the cloth, even when sharp teaseling is required, by teaseling with two sets rather than to shorten the operation by using sharp teasels. For this, of course, he must be allowed the necessary time.—*Jour. of Fabrics.*

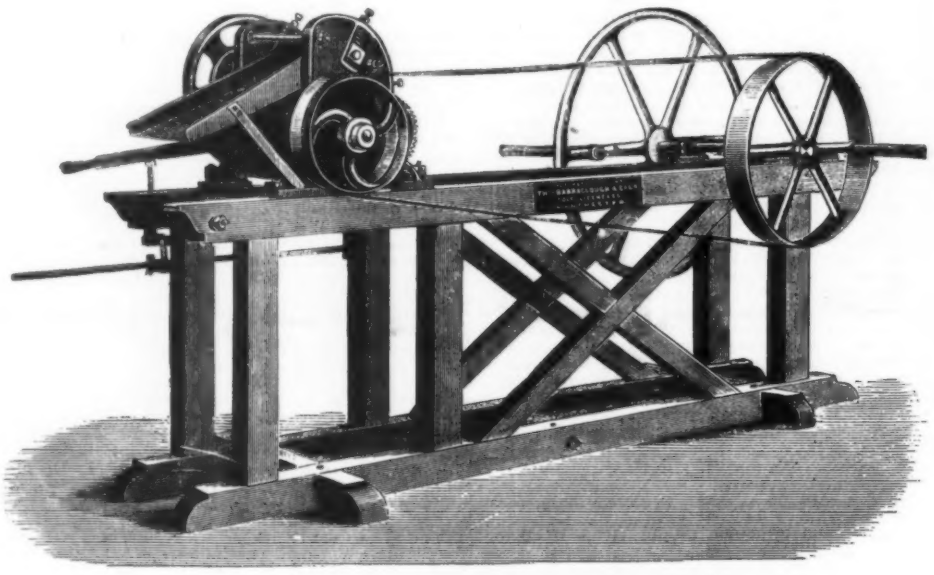
A MICHIGAN lumberman has adopted the use of pine roots as fuel for his hobby. He has the roots cut up into 18-inch lengths, and uses them in grates instead of soft coal, to which, he declares, they are superior.

IMPROVED DECORTICATING MACHINE.

THE slow progress which has been made in introducing ramie and similar fibrous stems into this market has probably in large measure been due, says the *Engineer*, to the want of a really good decorticating machine. With the object of providing a practical solution of this difficulty, and supplying the want of ramie cultivators, specially designed decorticating machinery, Landtsheer's patent, is being introduced by Messrs. Thomas Barraclough & Co., of Manchester, and we give an illustration of one type of these machines. In constructing this machine the inventor has specially aimed at producing an appliance which can be readily worked by any ordinary laborer, with the minimum liability to get out of order.

The apparatus in the larger form may be described as a combination of an agricultural with a textile manufacturing machine. This machine consists of two iron side frames connected together by wrought iron stays, so as to render it compact and strong without being unduly heavy. Between these frames are placed the working parts—a central steel bruising cylinder, round which are placed three steel rollers, one of which is the feed roller. The cylinder and two of the rollers are fluted, so as to impart to them a bruising action. The feed roller when treating green stems is partly fluted and partly plain, in order to flatten the stems during the feeding process.

When the machine is used for decorticating dried stems a special feed roller is inserted, and it is screwed round the periphery in order to effectually spread and flatten the dried stems when being fed into the machine. Below the cylinder are placed two decorticating drums, each furnished with a series of special steel blades. The construction and relative positions of these drums are such that when revolving the blades of one drum intersect the blades of the other drum, and thus effect the scutching or decortication of the fibers. The bearings of these drums are so arranged that they can be set nearer together or farther apart in order to regulate, according to requirements, the amount of intersection of the steel blades. The machine works continuously so far as the decorticating drums are concerned, but the main cylinder, the feed roller, and the other rollers are reversible by means of a simple and ingenious mechanism, the effect of which is that by a slight, almost imperceptible, movement of the knee of the person feeding the machine, these parts can be instantaneously reversed at will as many times per minute as desired. The mode of reversing is so mechanically perfect that there is not the slightest shock or strain on the machine, and the fibers are not deteriorated or shortened by the reversing action.



IMPROVED DECORTICATING MACHINE.

When working green ramie stems and green fibers, a jet of water is applied between the decorticating drums, so as to cause the steel blades not merely to decorticate the stems, but to wash the fiber at the same time. This combination of the mechanical action of these blades with the supply of water is exceedingly efficacious in the cleaning operation, as the fiber is not damaged, a good color is insured, and the degree of after washing is reduced. The machine is furnished with an iron feed table, which receives the ramie stems previous to treatment, and also the decorticated fiber after the process is complete. The feed rollers and the two bruising rollers have their journals fixed on slides; pressure is supplied to these journals by means of springs and set-up screws, so that the degree of pressure exerted on the material that is being treated is variable at will, and the pressure, however great, always remains elastic. The decorticating drums are 20 in. long in the blades. It will be interesting to describe briefly the operations carried out by this machine. The decortication of the stems is composed of two distinct operations combined in one machine, and effected at one and the same time. The first operation is to bruise the stems, and to divide as much as possible the inside woody pith without deteriorating the fibrous bark or outside of the stem. This is effected by means of the fluted cylinder and of the fluted or partially fluted rollers, according to the nature of the stems. The second operation consists in freeing the fibers from the woody interior and from the resinous skin which covers the fiber. It is called the decortication of the flattened stems, and is effected by means of two scutching or decorticating drums running at a high speed. In order to effect as complete a decortication as possible, the stems, after passing between the scutching drums, are caused to return by means of the reversing actions of the cylinder and rollers; and it is during the return or withdrawal of the stems from the machine that the principal decortication takes place.

From fifteen to twenty stems are fed into the machine at a time, all with their root ends in lines. When the stems have passed into the machine until the roots are just about to disappear underneath the feed roller, the workman reverses the machine by a slight touch of the lever with his leg; the stems then return with the fiber decorticated. The workman then lifts the bunch of stems from the feed table and hands them to another workman, who places them on a table, always keeping the root ends in the same line. The inferior part of the fiber being in the root ends, these are in many cases cut off by means of a knife fixed to the table, thus leaving the best fiber decorticated and washed. In other cases it is desirable to extract from the stems the whole of the fiber contained therein, even that which is near the root ends, and the operation is very simple. When the bunch of stems is withdrawn from the machine the workman takes hold of them and feeds them again into the machine, the root ends first. In this way the stems at their root ends are bruised and decorticated, so that the whole operation in this case consists of first feeding the bunch of stems into the machine tops first, and when they have returned feeding them into the machine a second time the reverse way. Our illustration represents a hand power machine, which is made especially for those persons who desire to experiment and try the cultivation and decortication of ramie on a small scale. It is also suitable for small farmers who have not the means nor the amount of fiber for the full sized machine. This apparatus is constructed on the same principle as the machine previously described, and has decorticating drums 14 inches long in the blades, with one center steel cylinder and two steel rollers, and it is mounted on a wooden frame. These machines are also capable of treating the stems either in the green or in the dried state.

THE VICTORIAN TRAVELING DAIRY.

THE traveling dairy which has been instituted by the South Australian government under the charge of Mr. D. Wilson, the Victorian government expert, was a center of attraction at the late agricultural show, which was opened on the old exhibition grounds on September 12.

The public have become accustomed to hear of the benefits which such a practical object lesson confers on all who are interested in butter and cheese making, but the dairy itself was a novelty which attracted a large amount of attention from all and sundry, as well as from the farmers and their wives and families who were present.

Mr. Wilson's show was placed in the inclosure near the south end of the grounds. A large and commodious marquee covered the whole of the apparatus, as well as a miscellaneous assortment of requisites for dairying, which were located outside the sanctum in which Mr. Wilson and his assistants operated. Needless to say that everything was bright and clean, spick and span, as a new pin, and that Mr. Wilson was indefatigably present everywhere, seeing that all the operations were properly conducted.

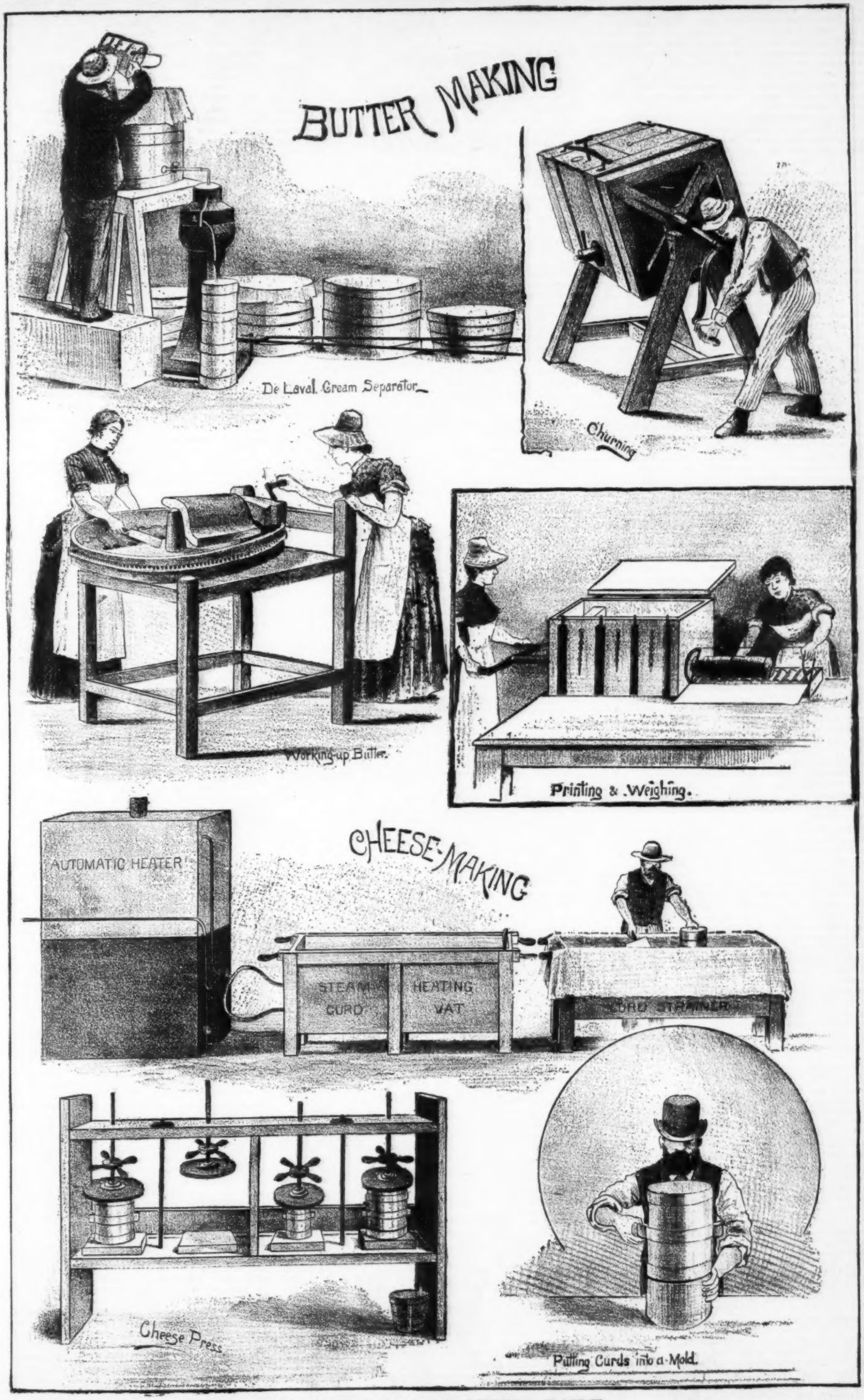
At one side of the dairy was a sort of bar or counter, ornamented with wild flowers, at which the produce of the dairy was dispensed by girl assistants to all who wished to buy, and a good trade appeared to be done during the afternoon.

The inclosure within which the dairying was carried on was supposed to be sacred against intrusion of the public, and solely devoted to the workers, but, as a matter of fact, it was pretty well filled during the day.

His excellency the governor and a number of M. P.'s and leading citizens were desirous of viewing the model dairy at close quarters, and it was found necessary to make a good many exceptions.

This is very well in its way, but it has the disadvantage that, while the more pushing townfolk obtain a close view of the working of the dairy, the country people, for whose instruction the exhibit is specially intended, are left outside to learn what they can from the little that comes within their range of vision. It is for this reason that in Victoria the traveling dairy is not exhibited at agricultural shows, but it is simply halted in the center of a farming district, and forms an exhibit *per se*, which the farmers and their wives and daughters have no difficulty in inspecting thoroughly.

Having obtained the *consigne* and passed the wicket, the visitor comes at once on the De Laval separator.



AN AUSTRALIAN TRAVELING DAIRY.

Without this all-important machine the factory system of dairying would be impossible. It enables the milk to be run through at the speed of 125 gallons per hour, the cream going into one vessel and the skim milk into another. The barrel which performs this ingenious operation travels at the rate of 6,000 revolutions per minute by the aid of one horse power.

Mr. Wilson assured me that in spite of this enormous speed the wear and tear of the machine is almost nothing, and there is no danger of any part being broken or getting out of order.

The De Laval separator is a Swedish invention, and is a testimony to the energy with which dairying has been pursued in Sweden; "a little country," says Mr. Wilson, "that has now for years sent her dairy produce into the British market, and regularly realized from 2d. to 4d. per pound more than the British farmer can do in his own market, simply because the Swedish government and private firms have established public dairy farms in several parts of the country, and have educated the young men and women to a high standard in the modern system of dairying, and have thus dairy farms to do more than pay all their expenses."

The credit belongs to Mr. Wilson of being the first to recognize the utility of the De Laval separator in this part of the world, and to introduce it to Australia.

After the cream is formed in the separator it is left overnight to mature, when it is ready to make into butter. The churn used for this purpose, which is the next implement, is another novelty. It is a square box without any works inside, and by a very simple action converts the cream into butter.

To the left of this is an ingenious butter worker and salter. Here the butter is lifted from the churn to the circular table, and after the milk has been thoroughly extracted from it, it is salted. The next machine the butter has to go through before being fit for market is the Eureka butter printer and weigher. Here the butter is forced through a circular hole, and comes out in roll form, and is cut and measured instead of weighed, the weight coming out thoroughly correct in pounds or half pounds. The article is lifted by the aid of butter pats on to butter paper instead of cloths, as hitherto, packed in boxes, and is then ready for market.

Farther round on this side of the platform are two or three hand cream separators; also De Laval's, capable of being driven by a boy or girl. One is called the "baby," and runs through twelve gallons of milk per hour, while the other is the "horizontal," running through thirty-five gallons per hour.

The next thing which attracts attention on this side of the platform is Wilson's style of cream cans, an invention of the energetic manager of the dairy. Here we have a narrow can of 9 in. diameter and 22 in. deep, with a perforated cover. It receives the cream from the separators, and by the aid of the same covers, the gases and heat of the cream are allowed to escape and the dust and insects are kept out. It also enables the operator to plunge the narrow cans into the tanks of water for cooling purposes.

Following round the platform we come to a self-acting cheese plant, comprising a vat capable of holding 100 gallons of milk, and a heater The heater contains a coil of inch piping that, by the aid of a little fuel, gets up hot water and steam in a few minutes.

By the turning of one tap it heats the milk to the necessary temperature, and by the turning of another tap allows it to go back to the boiler again when not wanted. In this same vat, after the milk is thickened, it is cut by what is called the American knives into small half inch square cubes, and after applying a gradual heat for a short time all the water and whey is abstracted from the milk. It is then strained and salted, hooped, and put under the press, and the work of the day in cheese making is generally done by two or three o'clock.

It is interesting to note that with the exception of the De Laval separators and the Eureka butter printer, all the articles used in the dairy have been manufactured in Adelaide by Messrs. Sandford & Co.

Mr. Wilson remarked that while the De Laval separator is allowed to enter both Victoria and New South Wales free of duty, on account of the impossibility of its being made in these colonies, owing to the patent rights, a heavy impost is levied on this useful machine when it enters South Australia. Not only was the whole of the plant of the working dairy manufactured in Adelaide, but the male and female assistants who conducted the operations, under Mr. Wilson's superintendence, were all local people, and he found them apt pupils.

As no cream had been prepared beforehand, it was impossible to make any butter on the Thursday. Some fifty or sixty pounds of local butter were put through the butter maker, with the result that they proved of poor quality, about a pint of milk being taken from them.—*S. A. Advertiser; Pictorial Australian.*

THE CHEMISTRY OF GLASS.

By Prof. GUSTAV GEHRING.

THE invention of glass is of great antiquity, and many nations have been contesting for the honor of its discovery. As the oldest known specimens were found among the sepulchral monuments of Egypt, its invention is in great probability due to that people. Among the wonderful ruins of that mysterious land are the royal tombs near Thebes. Built more than 4,000 years ago, we see in them already depicted the processes of glass blowing. The glass of Egypt was generally opaque and always colored. Most of the articles were small and were used for adornment. The Egyptians were acquainted with the art of cutting glass, and imitated successfully precious stones, such as amethysts, emeralds, lapis lazuli, turquoises, jaspers, onyx, and obsidian. Among the nations of antiquity second in renown to the Egyptians were the Phenicians, who are the legendary inventors. Glass making in Egypt has never become extinct, and though it has fallen to its lowest ebb, the degenerate descendants still manifest a considerable aptitude in this art.

In Greece, glass was unknown in the days of Homer, and even in the time of Aristophanes it was so rare that its value was next to gold.

At an early period glassworks were established in Italy, France, and Spain. For a long time the articles of that industry were of the commonest kind, and it was only after the introduction of Egyptian workmen to Rome that artistic glassware made its appearance in Europe. So rapid was progress that, already under Nero, Roman glass rivaled successfully the original Egyptian manufacture. There is an incident in history which gives us an idea of the value of those objects, since Nero is said to have paid 6,000 sesterces, or about $250,000, for two glass cups of ordinary size.

According to Pliny, we know that Egyptian sand and soda were employed, and that either rock crystal, or the material resembling it most closely, was highest in estimation. This is quite natural, when we consider that nearly all the substances employed contain metallic oxides, which give rise to certain colorations and render it in reality more difficult to produce colorless than colored glass. We cannot but be struck with the high scientific knowledge of the ancients, for they knew already the property of manganese as a decolorizing agent. Moreover, analyses of antique glass show that the colors were produced with identically the same materials as at the present time.

After the fall of the Roman empire this industry fled also east, and for five centuries Byzantium was renowned as its seat. On the decay of the Eastern empire, again it turned west, and while spreading over Europe found its firmest foothold in the republic of Venice.

Glass manufacture attained there during the sixteenth and seventeeth centuries its highest development, and the elaborate productions of Venetian art became famous throughout the civilized world. For more than a century, however, she has suffered decline, and it is only within recent years that she has recovered her original position.

In the meantime, there arose in Germany with the dawn of the middle ages an independent manufacture of glass. Mirrors seem to have been invented there, and the art of painting upon glass is of German origin.

In England and France this industry commenced at an early date, but in the latter country it was not until the eighteenth century, when German workmen were introduced, that the celebrated pure French glass was manufactured. France still excels in the production of plate glass, and of all the great works of that kind, Saint Gobain is the most important in the world. There is probably no country now where purer glass is made and where it is worked with greater skill than in Bohemia. Owing to the great purity of the materials occurring there, it is unrivaled in quality, and presents that absence of color for which it has long been famous.

When the Venetian industry fell into decay, so greatly flourished Bohemian art that her articles replaced Venetian glass throughout the world. But Bohemia, like Venice, suffered a severe check. The wanton destruction of her forests, the consequent lack of pure material, the high import duties, and the inducements of governments to her skilled workmen to settle in foreign lands, have been the causes of her decline. Not unlike Venice, it is only of late years that she has recovered her former position. Thus Venice, with her traditional fame and her present splendor, has found a rival in the forests of Bohemia.

The Venetian art products which figured in the late exhibition at Antwerp were not different from those that may daily be seen in the magazines of St. Marcus Place, and whoever has had the opportunity of admiring them must certainly have been struck by their majesty and, withal, their delicacy of form.

They had but one fault. Too elaborate in form and too rich in color, they reflect their oriental origin. The Bohemian glass, exhibited under the same roof, was conspicuous for its unaffectedness in color, and relied for its good effect principally upon the artistic cut of the object. Owing to the greater simplicity of these productions, they approach true art more closely and are certainly more pleasing to European taste.

Once again, Venice as she has shown herself in the universal exposition of Paris, just closed, has not impressed me so favorably as to change my opinion already expressed. It is evident that the noble art of that once mighty republic has in its turn fallen into the hands of greater and mightier nations than herself. Next to canvas, marble, and bronze, glass is now the material where the artistic taste of nations is most universally embodied. At the present hour, it is difficult to tell where this industry, in all its varied forms, stands in its apogee. Whether it is in Germany, or in France, or elsewhere, I cannot decide.

Among European countries, England, too, stands very high. In this difficulty even the report of the Universal Exposition, to which we look forward with great anticipation, will not be a crucial test, for France played the lion's share.

Germany proper, for I do not speak of the German industries of Bohemia and Venice, was not represented at all, and many other countries, especially the United States, very inadequately. We know, however, that our country in production ranks among the first, and even in purely ornamental glass it was made evident through the vessels exhibited by Collamore and the silver-incased flasks of Mr. Tiffany, in New York, that glass in this country is now cut with exquisite taste and remarkable skill.

Glass in its simplest definition is really any substance in a vitreous condition. It is amorphous. Crystalline substances, when broken under the hammer, divide naturally, or in other words present cleavage, such as rock salt or heavy spar. But glass when fractured breaks up irregularly and presents what is called conchoidal fracture. There are many substances occurring in nature which are vitreous, such as pumice stone, an aluminum silicate, which can be melted, but gives an imperfect glass.

A better example is obsidian, a natural glass, which on heating swells up and changes into lava. Artificial glass, perfectly colorless and transparent, may be easily formed on a small scale by simply melting together the ashes of certain plants. Thus, the ashes of wheat straw when heated on a platinum wire furnish a drop of glass, which is sometimes used as a microscope.

If we were to form glass from alkaline silicates, either simple or mixed, it would be amorphous, a property very desirable, but it would also be soluble in water and would melt at a temperature too low. On the other hand, the silicates of the alkaline earth metals are difficultly fusible, crystallize on solidification, and are easily attacked by acids. In order to obtain a glass which combines as nearly as possible all the desirable qualities, it is, therefore, necessary to form in proper proportions a mixture of an alkaline silicate with an alkaline earth or some other metallic silicate.

Perfect glass ought to have the following three properties: It ought to melt at a temperature not too high, and ought to preserve its viscosity sufficiently long in order to be worked. It ought not to devitrify. It ought to be unalterable by atmospheric as well as other agencies.

These properties are never found united in any glass, but industrial men endeavor at least to approach their ideal as closely as possible.

In reality, there are but two kinds of glass—glass proper is a silicate of potash and lime, or soda and lime, though the latter may still contain as impurity alumina and oxide of iron; and second, flint glass, or crystal, which is a potash lead silicate. These two kinds may be divided into four chief varieties, popularly known as:

Bohemian glass, a silicate of potash and lime. It is the most difficultly fusible glass, is soft, colorless, and is also the least attacked by chemical reagents.

Crown or window glass, a silicate of soda and lime. This is much more fusible, is harder, has a characteristic bluish tint, and is more soluble by acids than the preceding.

Bottle glass, a silicate of soda and lime, with variable quantities of alumina and oxide of iron as impurities; is less fusible than crown glass. It is still harder, varies in color from light green to brown, and is less easily attacked by acids than the preceding.

Flint glass, or crystal and strass; these are silicates of potash and lead. They are remarkable for their luster, great refracting power, and high specific gravity. In strass, a variety of flint glass, so called after its Austrian discoverer, these properties are exalted by an increase of lead. Flint glass is the most fusible glass, and is readily attacked by chemical reagents.

The two principal elements which enter into the constitution of glass are: Vitrifiable substances, such as quartz, sand and flint; fluxes, such as boric acid, phosphoric acid, alkalies, alkaline earths, and bases. It may be interesting to consider these substances briefly, inasmuch as they enter into the chemistry of glass making.

Silica is the only oxide which is formed by the burning of silicon in oxygen. Silicon, or silicium, is an element which, next to oxygen, is the chief constituent of the solid earth's crust. In the crystalline form, silica occurs as quartz and tridymite, and in the amorphous form as opal, flint, and sand. The purest form of quartz is rock crystal, which is usually colorless and transparent. But sometimes it contains traces of oxides of manganese, which give it a violet tint, and is then termed amethyst quartz. Other varieties, containing impurities, are known as milk, rose, and smoky quartz. Hydrated amorphous silica is formed by passing silicon tetrafluoride into water. This is a very beautiful experiment. Every bubble of the gas, as it rises in water, is immediately coated by a pellicle of hydrated silica, which rises like a little balloon to the surface of the water and then bursts. Quartz is harder than glass and scratches it with facility. When heated to redness and plunged into water it becomes perfectly white and friable, and is thus easily crushed to powder. By this method the planes of cleavage are easier to be found than with the hammer.

Fine splinters of quartz, mounted on stems of clay pipes, can be melted in the oxyhydrogen flame to a colorless glass, which remains transparent when cold. It can even be volatilized into white vapor. In geysers, it is contained in the vapor of water, and thus deposits of pure silica have been found in masses of several pounds. Silica is insoluble in water and acids, except hydrofluoric acid, but easily in alkalies and even in ammonia.

Like all substances, the finer the division, the easier it is soluble. The silicates of the alkalies only are soluble in water. They form the so-called soluble glass, which dissolves more readily, the larger the quantity of alkalies contained.

Helmont was acquainted with this property of the silicates, and was aware that acids precipitate silicic acid from such alkaline solutions. When crystals of zinc sulphate, calcium chloride, copper sulphate, nickel sulphate, cobalt nitrate, potassium bichromate, etc., are put into a high cylinder filled with dilute sodium silicate, and are allowed to remain at rest for some time, there will be formed long arborescent bands of various colors, white, blue, green, yellow, which have the charming aspect of a multicolor, subaquatic vegetation.

This phenomenon of arborescence is explained, if we consider that every crystal dropped into the liquid is really made up of an infinity of small crystals, each enveloped by a layer of air, which, rising to the surface, takes along a little of the solution of the crystal, which soon, in contact with the alkaline silicate, forms the variously colored insoluble silicates of those bases.

The use and properties of soluble glass were already described by Basil Valentine, an alchemist of the sixteenth century.

Fuchs, a chemist in Munich, in trying to prepare pure silica from ordinary soluble glass, discovered a new variety which had potash for its base. This compound, however, remained of no practical value until after the investigations of Liebig and Kuhlmann.

Soluble glass is excellent for cementing stone, glass, and porcelain. It has also been proposed for rendering the costumes in theaters incombustible. In the preparation of colors it may take the place of linseed oil and turpentine, and paintings thereby become more solid than by any other process known. This constitutes the stereochromy of Fuchs, which has been put in practice and perfected by Kaulbach. The illustrations of the Niebelungen which cover the walls of the royal residence in Munich are sufficient evidence of its success.

Since silica is too difficultly fusible and does not retain its viscosity sufficiently long to be worked, it could not form glass by itself. But it is necessary to mix it with other substances, which render it more fusible. On account of this they are called fluxes. The most important are:

Boric acid, which is contained in volcanic jets of steam, the so called suffioni of Tuscany, just as silicic acid is contained in the hot Icelandic springs. Boric acid when heated to redness loses its water, but it is necessary to heat for a long time, since the last bubbles of water rise slowly to the surface. The molten mass solidifies rapidly to a brittle, glassy solid. This substance scratches glass, is very hygroscopic, unites with water to form boric acid, and even in contact with the atmosphere slakes like quicklime. It is volatile at a

white heat only, and decomposes, therefore, at red heat all salts whose acids, or corresponding oxides, are volatile at a lower temperature. Thus carbonates, nitrates, sulphates, and other salts, when mixed with boric acid, are converted at a high temperature into borates. Most metallic oxides dissolve in fused boron trioxide at a red heat, many of them imparting to the vitreous mass characteristic colors.

Such glass is very hard and renders ordinary glass more fusible, but also harder. All borates are hard, but they are easily fusible. Calcium borate, for instance, is much more fusible than calcium silicate. Other fluxes, such as sodium carbonate, sodium sulphate, and potassium carbonate, are necessary to render glass more fusible and to prevent its devitrification. Formerly, the sodium sulphate which was employed always gave to glass some coloration, on account of the iron it contained. There is no longer any danger from this source. Since the process of its manufacture has been changed, it only contains traces of lead. Certain carbonates being exposed to air lose their water of crystallization, that is to say, they effloresce. Formerly, salts were divided into deliquescent and efflorescent salts, but this distinction has no *rationale*. In dry air all salts become efflorescent, and *vice versa*. Potassium carbonate, when anhydrous, is not good for glass making. It ought to contain about 18 per cent. of water.

Carbonates are excellent, inasmuch as they help to stir up the mass in fusion by disengaging carbonic acid. A solution of bicarbonate of soda in a strong bottle suffers already dissociation at the ordinary temperature in vacuo, and the carbonic acid thus liberated causes the liquid to enter into violent ebullition.

Lime is employed in the form of calc spar, marble, chalk, or common limestone. It gives glass a tendency to devitrify. There is an advantage in mixing silicates. Calcium and barium silicates are difficultly fusible by themselves, but a mixture of the two much more easily, and gives better glass. Thus, 46·5 parts of silica, 51·8 parts of barium carbonate, and 25·5 parts of calcium carbonate give a very beautiful and heavy glass.

Alumina, which is found in glass, is not added intentionally, but is introduced as impurity by the pots. It imparts tenacity.

Red lead is employed for good flint glass, for the more common varieties, white lead or litharge. The most prominent flint glass works in Pittsburg prepare the red lead themselves. Some years ago they sent for the lead bars to Missouri, but on account of the impurities contained, they now get it exclusively from Colorado.

Metaphosphoric acid is obtained in the form of a transparent, ice-like mass by evaporating the soluble trihydrogen phosphate and igniting the residue. If microcosmic salt is heated, water and ammonia are driven off, and a vitreous substance, sodium metaphosphate, is left. When metaphosphoric acid is melted in a platinum crucible, it can be drawn out into long fibers. Being only an accessory in glass making, it imparts opalescence. It is rather a coloring than a vitrifiable substance. Anhydrous acid calcium phosphate has the aspect of glass, but could not be used as such, since it is acid, and attacks the fingers.

Arsenious acid is only used for stirring up and brewing the molten mass.

The cullet, or broken glass, is employed to increase the fusibility of the mass in the pots. It furnishes good glass, but should not be taken from the blowpipes, since that always introduces some iron.

These are only some of the most important materials used in glass making. There are others which give color, but they are never added intentionally, such as the protoxide of iron, which gives a very beautiful blue or azure, and the sesquioxide of iron, which produces yellow. A mixture of the two, therefore, gives green. Traces of iron occur in nearly all the materials employed, and render it almost impossible to produce absolutely colorless glass. To counteract this, manganese dioxide is added. This is equivalent to bluing, a process analogous to the bluing of linen with indigo. Manganese dioxide as a decolorizer plays a double role. It oxidizes ferrous oxide into ferric, and by giving to glass a violet color, which is complementary to green, contributes to establish a neutral tint. Although a detergent by fire, it has at one time been called sapo-vitriariorum, or glassmaker's soap.

The materials used in glass making should be perfectly dry, so that they can be gradually fritted together in melting pots. Success or failure in this manufacture depends in large part on the quality of these pots and on their careful management. Only the most refractory sort of fire clay should be used. They ought to resist the flame as well as the material which they contain. The pots are always made by hand, and with extreme regularity.

In a certain factory in Belgium it was observed that the pots always cracked at the same height from the bottom. On investigation it was found that the workmen were accustomed to go to lunch just when they arrived at that height, and in consequence thereof, the pots dried too much at that place.

Oval pots are no longer used. For charcoal or gas they are always open, but if coal is employed, and particularly if flint glass is to be made, their tops are hooded in the shape of a dome, and present an opening like a muffle. They ought not to be thick, for there is too much loss of heat. In Bohemia they are usually very small. On the contrary, in England, there are pots which hold 2,500 kilos. of glass.

The melting furnaces are also of the highest importance. The oldest forms are used for discontinuous work. Either sandstone or blocks of the most refractory fire clay are employed in their construction. But since all the perfections and inventions in our modern processes of manufacture tend toward non-interrupted, continuous action, it was to be expected that the modern glass furnaces would be of that kind. Among the most successful is Siemens' heat regenerating furnace for continuous glass melting. It consists of a gas generator, a melting furnace, a gas regenerator, and a system of tanks. Combustion in these furnaces is wonderfully complete, so that the gases which escape are one-third by volume nitrogen. Furnaces of that kind have many advantages, and also their disadvantages, which, in some places, do not render them feasible. Among the advantages are :

1. Economy in fuel from 40 to 50 per cent., and for very poor combustibles, even as high as 60 per cent.
2. Great heat—even bricks can be melted.
3. Great purity of flame.
4. No variation in temperature, and consequently no shocks to the pots.
5. Economy in working space.
6. No fumes, no smoke.

The disadvantages are that—

1. It is expensive and needs much space and skilled hands.
2. It presents difficulty for reheating. When a mass of 16 or 20 lb. is worked it is necessary to reheat on the blowpipe. For this purpose, in England, often ordinary furnaces are placed at the side of Siemens' furnace.
3. When the coal is fat, there is danger of choking.

Another furnace which is at the command of smaller industries is the Boetius furnace. This furnace can be made quite small, and gives a pure flame. The air, before it is allowed to enter for combustion, is heated. It does not produce an economy comparable to Siemens.

A happy modification of Siemens is the Appert furnace, in which air is made to circulate so as to become very hot. A very pretty model, in value of 1,100 francs, is preserved in the Conservatory of Paris. The mass of glass in fusion in this furnace is about 120,000 kilos. Wherever much piece work of the same kind of glass is in demand, such as bottles, for instance, it is excellent ; 24,000 bottles can be made in one day. In this country the Ferrari furnace is a great improvement.

On account of the enormous expansion of viticultural interest in California, good wine bottles will for many years be in constantly increasing demand. The acreage planted in vines in California has increased from 65,000 acres in 1881 to 250,000 acres in 1887. In 1888, from this source alone, 30,000,000 gallons were expected. Home consumption is so great that the price is as yet by far too high for exportation. There is consequently no danger of overproduction. The capital invested in viticulture in California is estimated at $75,000,000.

France, an eminently viticultural country, manufactures annually 180,000,000 bottles, at a value of 35,000,000 to 40,000,000 francs.

Though we may not all be interested in wine, yet industrial men cannot afford to neglect opportunities which open new avenues to their enterprise. They ought to do at least as Chevreul has done, who says of himself : "I never drank but water, and still I am president of the Society of the Wines of Anjou—but honorary president only."

A few years ago I was informed by some of the leading wine farmers in California that most of the bottles needed in their industry were imported from Europe. I was told that they had tried repeatedly American manufacture, but on account of breakage and other causes, they found it more advantageous to have them imported from Germany, for instance, in spite of the cost of transportation. At first sight it would seem to be an easy matter to make a first-class wine bottle ; but in reality it is not, although bottles were known in the remotest antiquity.

Ancient Egypt has left us smooth bottles of various forms, as well as those covered with papyrus and wickerwork. At the present time, the latter are still called by the native Egyptians damadjan ; hence our English word demijohn.

Nor is it too much to say that this subject has, during many centuries, taxed to the utmost the knowledge and ingenuity of the chemist, in order to produce a glass which is not attacked by the liquid, and consequently does not deteriorate it; and finally the artist, if I may be allowed the expression, who in shaping it combines lightness with strength and beauty. This is particularly true in the case of champagne bottles. Resistance is imperious. The pressure in such bottles is from four to six atmospheres.

A really first-class champagne bottle, however, is expected to resist a pressure of 30 atmospheres. There is a case on record in the champagne districts of France where out of 6,000 bottles only 200 did not burst. Formerly, the breakage amounted to 60 per cent. At present, it has been reduced on an average to 15 per cent., though occasionally it rises even to 30 per cent.

Having now studied separately the properties of the various vitrifiable substances, we may take under consideration the method of operating the melting. The substances which are intended for use are generally mixed with "cullet," or broken glass, to facilitate fusion.

Having previously been fritted, the material is put in small quantities into the highly heated pots and allowed to melt before a new charge is added. When the pots are filled and the mass is completely liquid, it is still porous or spongy, on account of the gases, which are constantly discharged. Furthermore, the surface is covered with a scum of chlorides and sulphates of potassium and sodium and still other impurities. The formation of scum, technically called glass gall, or sandiver, is now avoided by the use of purer material, and if salt cake is an ingredient, charcoal is added, just enough to prevent the glass from turning yellow. To effect what is called "fining," the heat is raised to its maximum. Thereby the glass is rendered as mobile as possible.

All gas bubbles rise to the surface, and whatever material may not be vitrifiable will sink to the bottom. Then the heat is allowed to diminish gradually to render the glass sufficiently viscid for work.

Glass is converted either into blown glass articles by the skill of the workmen or cast into moulds or presses, or simply poured on iron tables and rolled into plates. The tools are of the simplest description. Everything depends on the skill of the workmen.

The principal property of perfect glass is its homogeneity, or homogeneousness. Imperfect glass has a tendency to devitrification. Common glass has the least specific gravity. The densest is that of thallium. Lamy, who made the discovery of this element independently of Crookes, had the happy idea to replace the potash in flint glass by the oxide of thallium.

According to an expression of Dumas, thallium is a paradoxical metal. In its physical properties it resembles lead, having even a higher specific gravity, namely, 11·8, but in its chemical properties it is allied to potassium and comes after it.

Kinds of glass.	Sp. gravity.
Crown glass	2·53
Fraunhofer's flint glass	3·13
Lamy's thallium glass	4·18
Strass, extra heavy	4·81
Faraday's flint glass	5·44
Thallium glass	5·62

Glass is characteristic for its transparency and has always some color when sufficiently thick.

It has different indices of refraction. Phenic acid has very nearly the same index of refraction and dispersion as ordinary glass. Hence, if a glass rod be put into liquefied phenic acid, it will generally disappear.

Mascart, in 1874, observed one day in a laboratory in Paris that a glass rod, twisted like a corkscrew and plunged into phenic acid, liquefied by a small quantity of water, had become almost invisible by transmitted light, though by reflected light it could still be perceived on account of threads and other imperfections in the homogeneity of the glass. Hence, if the refrangibility and dispersion of a perfectly homogeneous block of glass be exactly the same as that of some liquid, it will disappear in it completely.

To every tone in music corresponds a certain number of vibrations, and to change the number of vibrations is to change the tone. The same is true in light. By changing the number of light vibrations in a given time, we change the wave lengths of light, and thereby change also the kind of light, that is the color.

Glass is very malleable and ductile. Capillary tubes of very fine diameter are sometimes made prismatic in form, in order to increase their luster. A thermometer tube of very fine diameter had been spun so rapidly as to produce 90,000 feet of thread per hour. The thread was extremely fine and its interior diameter scarcely calculable. But it was nevertheless hollow. Being cut into pieces of an inch and a half long, one end was put in contact with the receiver of an air pump, and the other was plunged into mercury. It was observed that on producing the vacuum the mercury passed through the tube in a very thin thread. Spun glass can be woven into cloth. Especially when mixed with silk it is employed for church garments. Also, perukes have been made to imitate white hair. Brushes for burnishing brass, silver, and gold are very useful. Glass wool, or "mineral wool," as it is called, being a poor conductor of heat, may be useful in many cases. It is manufactured in New Jersey.

According to Mr. Emery, if a cover of fur—best nonconductor of heat—is equal to 100, a similar layer of mineral wool, 5 centimeters thick, is equal to 83·02.

In Germany even lamp wicks are made of spun glass. Petroleum and alcohol in such lamps ascend more regularly, and they are also safer. With flames of equal size, these glass wicks give a purer and brighter light. They produce a less disagreeable odor, consume less combustible, and give with alcohol lamps a greater heat and a steadier flame.

Spun glass has also been applied with good effect in the imitation of objects of natural history. There is in the Conservatory of Paris a lion of natural size, and at his feet a snake, which creeps over moss, through grass and flowers, on which tiny insects swing themselves, all made of spun glass and resembling nature as faithfully in color and form as anything of the kind that has ever been attempted in wax.

Glass may be cut with a diamond, with hardened steel, with a drop of molten glass, with a cord by friction, with a red hot wire, with specially prepared sticks of carbon, with a comb-shaped burner, having many fine flames, before which the object to be cut is rapidly turned.

Several manufacturers now cut the large cylinders of window glass by encircling them with a fine wire, which is then heated to redness by an electric current, and a drop of water being allowed to fall upon the hot glass produces a clean separation.

By the old method a string of semi-molten glass was wrapped round the cylinder. A high, large bottle may be cut with a stick of glowing charcoal, so as to form a thin spiral ribbon from neck to bottom. On raising it by the top it acts like a metallic spring and illustrates well the elasticity of glass.

Defects in glass are rather of a physical nature, and are commonly due to bad heating, but also to faulty composition. They are numerous, such as : Bubbles of oxygen, sulphur dioxide, carbon monoxide, carbon dioxide, or air which are inclosed in glass. Bouillons are bubbles of air introduced on taking glass on the blowpipe for a second time. Moss, very fine bubbles, is due to a too low temperature in the pots at the beginning of the fusion, or to an overheating of the pots on the top and not enough on the bottom, also to dust. Gall is a wart-like excrescence on the surface. Grease is a rough, blistered surface—just as if it had been rubbed with a greasy rag. Its formation is not well understood.

Other defects are : Tears, threads, waves, cords, knots or grains, streaks, which often determine the rupture of vessels on such places.

(To be continued.)

CLOUDS AND CLOUD WATERS.

AT a recent meeting of the Berlin Physical Society, Prof. Von Bezold spoke on the various causes which lead to the production of clouds and aqueous precipitates. Using the graphic methods which he had himself introduced into meteorology, he showed by means of diagrams that the older ideas on this subject are insufficient, and that, even in the case where both masses of air are saturated with aqueous vapor, the precipitation which may occur when they are mixed is not due to the mere mixing of warm and cold air : the temperature of the mixture is not the mean of that of the respective masses of air, but is somewhat higher, and the amount of water which is condensed on their mixing is very small. By means of his diagrams a simple solution is at once obtained of many problems which have reference to the temperature and humidity of masses of air when they are mixed together in unequal quantities. It appeared that under the most favorable conditions, when air saturated with aqueous vapor at 0° C. is mixed with air saturated at 20° C., under a pressure of 700 millimeters of mercury, only 0·6 gramme of water is condensed out of 2 kilogrammes of the mixed portions of air.

The same mass of water would be condensed out of the same mass of air saturated at 20° C. if its temperature were reduced to 19°·3 C., or if the air were to ascend through a height of 200 meters, in which case its temperature would fall to 18° 9 C. Much more aqueous precipitates are formed when moist air is either cooled directly or has its pressure reduced by rising upward, in which case a simultaneous cooling occurs. When air saturated at 20° C. is cooled down to 10°·7 C.

—a temperature which results from mixing air at 24° C. with air at 0° C.—4·4 grammes of water are precipitated out of each kilogramme of air, and if the temperature is reduced to 0° C., 8 grammes are precipitated.

Similar falls of temperature may be obtained during an adiabatic rise in altitude. The conditions which hold good for supersaturated air may similarly be comprehended by this graphic method. Notwithstanding that the formation of aqueous precipitates by the mere mixing of two masses of air is thus shown to be very minimal in amount, still it does occur in nature as the result of this cause, as, for instance, in the case of cloud caps formed when different winds meet, and in the case of the formation of ground fogs. According to the speaker, clouds ought to be distinguished by reference to the way in which the precipitate of which they consist is formed, rather than by the casual appearance which they present to the eye; in any case, mist and clouds must in the future be studied from the above new point of view. Prof. Von Helmholtz added to the above communication some remarks on the way in which the mixing of two fluids of different specific gravities is brought about.

Such mixing is only possible as the result of vortex movements or of "breaking" waves. He had already dealt with the production of vortices, and the production of waves has recently engaged his attention, inasmuch as this problem has, up to the present, only been regarded from a one-sided point of view with reference to water, without taking into account the influence of the air which is moving over its surface. When wind blows over the surface of water, or when lighter air streams over a mass of heavier air, waves are formed, whose size and rate of propagation depend upon the relationship of the two fluids which are moving one over the other. To obtain the mechanical equations of these movements was the problem which he had set before himself for solution in a communication which he had recently made to the Berlin Academy. This dealt first with waves on water, and then the conditions involved in these were transferred to the consideration of waves in air. Waves 1 meter long on the surface of water, which are frequently met with in nature, correspond to waves in air 21 meters long—that is to say, to air waves which extend over a considerable stretch of land. Waves in air are only visible in the cases where they are accompanied by condensations of vapor, the latter occurring in the case where the air rises several hundred meters to the crest of a wave. Prof. Helmholtz pointed out that the most important outcome of the whole theoretical consideration of the problem was the following: a quiescent surface of water over which a wind is blowing is in a state of unstable equilibrium; as the result of this, waves are produced as soon as the wind acquires a sufficient velocity, and the energy required to raise the water from the trough to the crest of each wave, as well as to produce the onward motion of the wave, is derived from the more rapidly moving lower layers of air of which the wind consists. Friction plays a very subordinate part in the whole process.—*Nature.*

ON THE SPECTRUM OF ζ URSÆ MAJORIS.*

By EDWARD C. PICKERING.

IN the third annual report of the Henry Draper memorial, attention is called to the fact that the K line in the spectrum of ζ Ursæ Majoris occasionally appears double. The spectrum of this star has been photographed at the Harvard College Observatory on seventy nights, and a careful study of the results has been made by Miss A. C. Maury, a niece of Dr. Draper. The K line is clearly seen to be double in the photographs taken on March 29, 1887, on May 17, 1889, and on August 27 and 28, 1889. On many other dates the line appeared hazy, as if the components were slightly separated, while at other times the line appears to be well defined and single. An examination of all the plates leads to the belief that the line is double at intervals of fifty-two days, beginning March 27, 1887, and that for several days before and after these dates it presents a hazy appearance. The doubling of the line was predicted for October 18, 1889, but only partially verified. The line appeared hazy or slightly widened on several plates, but was not certainly doubled. The star was, however, low, and only three prisms could be used, while the usual number was four. The predicted times at which the line should be again double are on December 9, 1889, and on January 30, 1890. The hydrogen lines of ζ Ursæ Majoris are so broad that it is difficult to decide whether they are also separated into two or not. They appear, however, to be broader when the K line is double than when it is single. The other lines in the spectrum are much fainter, and although well shown when the K line is clearly defined, are seen with difficulty when it is hazy. Several of them are certainly double when the K line is double. Measures of these plates gave a mean separation of 0·246 millionth of a millimeter for a line whose wave length is 448·1, when the separation of the K line, whose wave length is 393·7, was 0·199. The only satisfactory explanation of this phenomenon as yet proposed is that the brighter component of this star is itself a double star having components nearly equal in brightness and too close to have been separated as yet visually. Also that the time of revolution of the system is 104 days. When one component is approaching the earth, all the lines in its spectrum will be moved toward the blue end, while all the lines in the spectrum of the other component will be moved by an equal amount in the opposite direction if their masses are equal. Each line will thus be separated into two. When the motion becomes perpendicular to the line of sight, the spectral lines recover their true wave length and become single. An idea of the actual dimensions of the system may be derived from the measures given above. The relative velocity as derived from the K line will be 0·199, divided by its wave length 393·7, and multiplied by the velocity of light 186,000, which is equal to 94 miles a second. A similar calculation for the line whose wave length is 448·1 gives 102 miles per second. Since the plates were probably not taken at the exact time of maximum velocity, these values should be somewhat increased. We may, however, assume this velocity to be about one hundred miles per second. If the orbit is circular and its plane passes through the sun, the distance traveled by one component of the star regarding the other as fixed would be 900,000,000 miles, and the distance apart of the two components would be 143,000,000 miles, or about that of Mars and the sun. The combined mass would be about forty times that of the sun to give the required period. In other words, if two stars each having a mass twenty times that of the sun revolved around each other at a distance equal to that of the sun and Mars, the observed phenomenon of the periodic doubling of the lines would occur. If the orbit was inclined to the line of sight, its dimensions and the corresponding masses would be increased. An ellipticity of the orbit would be indicated by variations in the amount of the separation of the lines, which will be considered hereafter. The angular distance between the components is probably too small to be detected by direct observation. The greatest separation may be about 1·5 times the annual parallax. Some other stars indicate a similar peculiarity of spectrum, but in no case is this as yet established.

ADDENDUM, December 17.—The predicted doubling of the lines of ζ Ursæ Majoris on December 8 was confirmed on that day by each of three photographs. Two more stars have been found showing a similar periodicity: β Aurigæ and *b* Ophiuchi (H. P. 1,100 and 2,909).

Harvard College Observatory, Cambridge, U. S., Nov. 12, 1889. —*Amer. Jour.*

* Read at the Philadelphia meeting of the Nat. Acad. of Sciences, Nov. 13, 1889.

THE GREAT NEBULA IN ANDROMEDA.

WHEN we search the heavens with a telescope of small magnifying power but a large field, we come upon objects which give a light similar to that of the milky way and are called nebulæ. They are of various forms and sizes, ranging from one degree to a few seconds in size, and from round, circular, or elliptical to great irregularity in form. Sometimes little stars are seen in such nebulæ, or there is a visible thickening of the nebulous matter toward the center. What appear in telescopes of small power like light clouds separate into stars when viewed through a stronger glass, forming star clusters; in other nebulæ no separate stars can be discerned, but an impression is received that they consist of many stars crowded close together. There are, besides these, a great many nebulæ which cannot be resolved into stars at all.

THE GREAT NEBULA IN ANDROMEDA.

The distinction between the real nebulæ and the star clusters was first discovered by the help of spectrum analysis. The spectrum of the star clusters is a continuous one, while that of the nebulæ consists of one or more (generally three) bright lines; the light of the clusters of stars seems to come from bodies in a glowing liquid or solid state, and that of nebulæ from glowing gases. The English physicist and astronomer Huggins was the first to make this spectroscopic examination, and found the line spectrum (gas spectrum) in nineteen nebulæ, and a continuous spectrum in thirty-eight clusters of stars and separable nebulæ. According to the investigation of Huggins and H. Vogel (of Potsdam), the nebulæ consist principally of nitrogen and hydrogen.

Another great aid besides the spectroscope in solving many questions in regard to the physical nature of nebulæ is photography, which has been used so much of late years in examining the heavenly bodies. Some years ago a plan was devised for obtaining a photograph of the entire heavens by the co-operation of a series of observatories; the preliminaries for carrying out this plan are already in full operation. Besides this great work, which will require several years, and indeed before this idea was conceived, special investigations in this field have been undertaken by different astronomers, with very happy results. One of these enthusiastic devotees, Mr. Isaac Roberts, of Liverpool, has taken photographs of various objects, among which is one of the great nebula in Andromeda, that he took on December 29, 1888, by exposing a plate for four hours in the focus of a mirror telescope of 20 inches diameter.

The great nebula in Andromeda is one of the most regular in form, and can be seen by the naked eye more easily than the one in Orion, because there are no bright stars in the neighborhood of the former, and it has the appearance of a nebulous star. As early as the tenth century this nebulous star was mentioned by the Persian astronomer Sufi; but it was first seen in Europe in 1612 by Simon Marius, who compared its light to that of a candle shining through a plate of horn. Later observers, before the time of William Herschel, noticed little more than that the nebula was brighter in the middle; Herschel thought that the central part could be resolved into stars. In the year 1848 G. P. Bond, of Cambridge (United States), used a refractor with a fifteen inch opening, and counted 1,500 little stars within the limits of the nebula, without losing the nebulous outline of the whole. Through the nebula pass two dark belts like two breaks. Bond considers that this nebula can be separated into stars, and the spectroscope seems to uphold him, for it gives a continuous spectrum, such as always comes from the combined light of groups of stars, and the spectrum of the nebula is not to be found. The nebula proper seems to be behind the stars, which impression is also given by Roberts' photograph. Further, it can be clearly seen that the great nebula consists of rings which surround a bright center, and in some parts of these rings knots of nebulous matter are visible; such a one can be seen at the right of our picture. It was probably separated from the main body, as it shows no connection with the same.

In August, 1885, a bright fixed star suddenly appeared near the center of this nebula which was visible for several months, and then vanished. Whether it had any connection with the nebula or was only seen there by chance could not be determined.

The great Konigsberg philosopher, Kant, advanced, more than one hundred years ago, in his work "Allgemeine Naturgeschichte und Theorie des Himmels" (Universal Natural History and Theory of the Heavens), a hypothesis based on the supposition that our system, for example, had been formed by the condensation of an immense nebulous mass; from which nebulous mass single parts had broken away, and of these parts the planets and their moons were formed. We can consider the nebula now visible to be such systems in process of construction; but as immense periods of time, incomprehensible to the human mind, are required for the formation of these systems, and the changes cannot be watched, we must be satisfied with hypotheses.

Our illustration of the great Andromeda nebula after the Roberts photograph is a reproduction of a photolithograph which appeared in the periodical "Gaea," published by Ed. H. Mayer, in Leipsic.—*Illus. Zeitung.*

NOTES ON COMETS.

Periodic Comets to Return in 1890.—Mr. W. T. Lynn, in *Knowledge*, Dec. 2, 1889, p. 33, and Mr. W. E. Plummer, in *The Observatory*, December, 1889, p. 432, give brief notices of the periodic comets whose return to perihelion is to be expected in 1890. There are four, possibly five of them, all telescopic and of short period, belonging to the Jupiter family of comets. Of these, two, Brorsen's and D'Arrest's, have been observed at several apparitions, but both escaped detection at the last return. The other three have been seen only at one apparition, so that their periods are somewhat doubtful.

Barnard's Comet 1884 II. was discovered July 16, 1884, by E. E. Barnard, at Nashville, Tenn. The period assigned by Dr. Berberich is 5·36 years, so that this comet should be now very near perihelion. The elements of this orbit bear a close resemblance to those of the lost De Vico comet, 1844 I., and also to those of Finlay's comet, 1886 VII. They cannot be identical, but probably belong to a system of faint comets which escape observation except when their perihelia are favorably situated with reference to the earth.

Brorsen's Comet was discovered at Kiel, Feb. 26, 1846. Its period is very nearly five and one-half years, so that its apparitions occur alternately in the spring and autumn. It was seen in 1857, 1868, 1873, and 1879, but escaped observation in 1884. It is due at perihelion this year about February 25, its course passing through the constellations Pisces, Andromeda, and Cassiopeia. It should not escape detection this time. In another place Mr. G. A. Hill gives a sweeping ephemeris which will aid observers in their search for the faint visitor.

Mr. Plummer says: "The orbit is a very interesting one, for it approaches very closely to that of Jupiter, and at intervals of ninety-five years the comet encounters the planet, and a very decided change in the orbit ensues. This close approach last occurred in 1842, May, when the comet's motion, which had been previously hyperbolic, was changed into the elliptical form in which the comet now moves. In 1937 this proximity will again take place, when the orbit will probably resume its hyperbolic curve, and be lost to the solar system."

Coggia's Comet, discovered Nov. 10, 1873, was thought, from the investigation of Professor Weiss, to be identical with one detected Feb. 23, 1818, by Pons, but, although the derived period is about five and one-half years, it has not been seen since 1873. If this period is correct, the comet is due early in 1890. We have no ephemeris at hand.

Denning's Comet 1881 V., discovered at Bristol, Oct. 4, 1881, has been thought to be identical with that discovered by Blanpain, Nov. 28, 1819, for which Encke derived a period of 4·8 years. The most reliable orbit of Denning's comet, however, gives a period of 8·6874 years. This period, computed by Dr. Boy Matthiesen (A. N. 121, p. 359), has a probable error of only four days, so that the comet should come to perihelion in May, 1890, but with a theoretical brightness of only one-third that which it had when discovered in 1881. Also the comet in 1887 approached very near to Jupiter, so that its orbit may have suffered considerable perturbations, which must be calculated approximately before a sweeping ephemeris can be computed.

D'Arrest's Comet was discovered at Leipzig June 27, 1851; it has a period of six and a half years and was seen in 1857, 1870, and 1877, but was not seen at its last return in the winter of 1883. According to Winnecke, this is the faintest of the periodic comets, but its course this year will be similar to that which it followed in 1883, when it was a fairly conspicuous object in the telescope. This comet is due at perihelion about the third week in September. An accurate ephemeris will doubtless be soon published. Such ephemerides have hitherto been issued by M. Leveau, of Paris.—*Sidereal Messenger.*

HOW THE CETACEA NURSE THEIR YOUNG.

IN most mammals, lactation is effected under the influence of a direct and effective action of the young animal, which, by repeated acts of suction, acts after the manner of a suction pump and draws from the mammary glands the milk that they secrete. To draw milk from the breast, then, is to suck, and this supposes at least that the act takes place in the air. After every

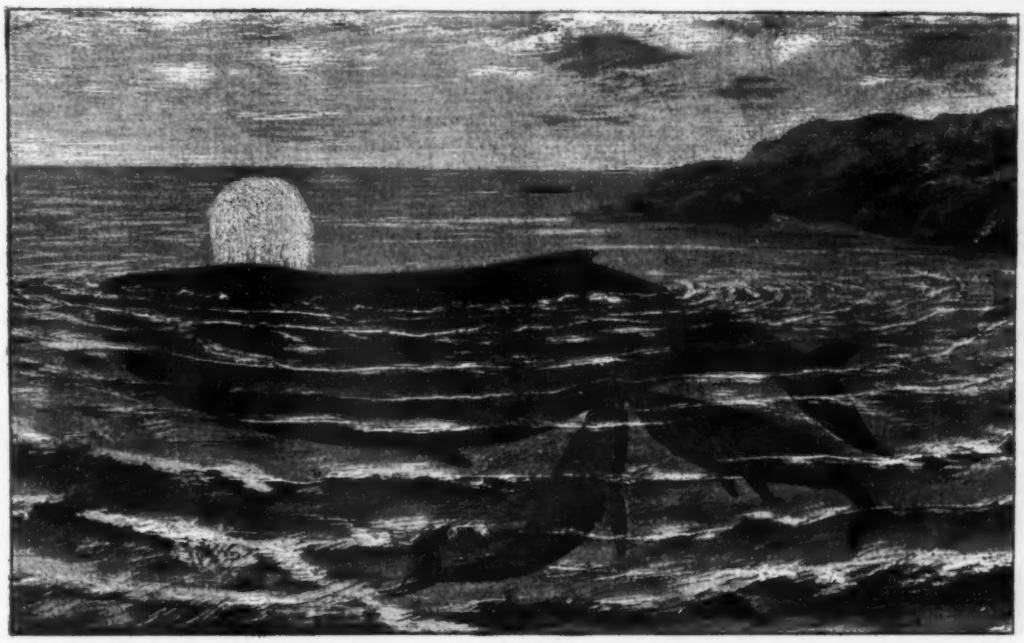


FIG. 1.—A WHALE NURSING ITS YOUNG.

suction, in fact, the air must penetrate the buccal cavity in order to be expelled from it at the moment another suction takes place. Yet, although the presence of the atmosphere is a necessity in the phenomenon under consideration, we cannot consider this to be always sufficient. If the young animal is too weak at its birth to adapt itself to the mechanism of suction, it will play a purely passive role in lactation, as all the activity thereafter devolves upon the mother, who will compress her breasts and cause the milk that they contain to flow into the mouth of the young animal. It is in this way that are nursed, at the beginning of their existence, the young marsupials and monotremata. Imperfectly formed and very small and incapable of any effort, these young animals remain suspended from the maternal flanks, and passively receive the milk that the mother is continually secreting for them.

The cetacea live in water, and cannot leave that liquid. They are, therefore, placed under conditions that render the phenomenon of suction impossible. Moreover, as Rapp truly remarks, they are organized as badly as possible for being in a state to suck. Their buccal cavity is very long, and, in some, extends like a

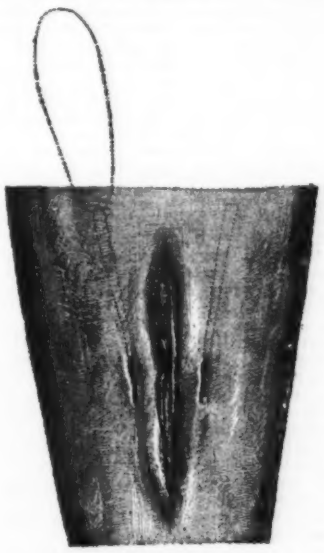


FIG. 2.

beak, and the edge of the lips are hard, fat, and almost immovable. Finally, the elevated position of the larynx, which may penetrate as far as to the posterior nares, in dividing the pharynx into a right and left conduit, appears to be but little favorable, as Hunter observes, to the mechanism of suction.

The object of this article will be to show what the modifications are that the adaptation to an aquatic life has introduced into the structure of the breasts and into the mechanism of lactation of the cetacea.

Like those of other mammals, the breasts of the cetacea are formed by an epidermic invagination, upon whose sides are produced a nipple and two lateral grooves. These breasts are two in number. In the adult they are situated at the sides of the ventral median line, and their nipples, hidden at the bottom of a bilabiate slit (Fig. 2), are situated at the sides and at a short distance from the vulva. The nipple (Fig. 3) is provided with papillæ, and terminates in a single orifice, as in the cow, certain marsupials, and some rodents. The orifice of the nipple leads to a canal which soon widens into a reservoir that receives all the conduits of the gland.

In the *Balænoptera Sibbaldii*, studied by Turner, the glands measured 2·4 meters in length,* and were situated almost entirely in front of the nipple. Their greatest transverse diameter was 0·5 meter. Each gland was accompanied in the direction of its great axis by a canal that served as a collector to the secondary conduits. At the base of the nipple this canal expanded into a reservoir 0·16 meter in diameter. The reservoir itself served as a starting point to a conduit that debouched, at the apex of the nipple, through an orifice into which the forefinger could be inserted. In the platanist, Anderson finds two reservoirs upon the central conduit. The posterior and smaller is situated at the base of the nipple, and gives rise to the outlet canal. It communicates by a narrow orifice with the front reservoir into which the milk ducts open. In the porpoise, which suckles, according to Rapp, the mammary gland (Fig. 3 C) attains nearly a fifth of the length of the body. It is as wide as the hand and two fingers in thickness, and the excretory canal that accompanies it in the direction of its great axis opens at its extremity. The reservoir is not described, but it had been figured and described already by Geoffroy Saint-Hilaire (Fig. 3 R).

The glands are situated between the platysma myoides and the abdominal muscles. They are surrounded with a conjunctive tissue deprived of fat and lax enough to allow the gland to dilate at the time of lactation. These muscles are evidently capable of compressing it, but it is provided besides with special muscles. In the platanist, Anderson describes a sphincter around the first chamber, capable of expelling the milk or closing the eduction canal. Murie ascribes the power to the *erector clitoridis* of the grampus of compressing the breasts. In the globicephalus, this function is fulfilled in addition by an ischiococcygeal muscle extended between the os pelvis and perineal raphe, and by a compressor of the breasts—a sort of sphincter connected with the fasciculi of the perineum. In the subcutaneous tissue around the nipple and at its base, Turner describes numerous plexiform vessels that are capable, according to him, of constituting an erectile tissue. He likewise describes a muscle designed to compress the breasts.

Amid all these divergences, there is one point upon which every one is agreed, and that is the existence of muscles designed to expel the milk from the reservoir in which it accumulates, and cause it to make its exit through the single orifice of the nipple, in the form of a jet.

Geoffroy Saint-Hilaire long ago pointed out this arrangement, not only in the cetacea, but also in the kangaroos and monotremes, and, in addition, showed how the mechanism of lactation in the cetacea was to be explained, by taking these muscles into account.

The gland, says he, is superficial and covered with a thin skin, and empties immediately into the udder in aerial animals; but in animals always immersed in water, the cetacea, it is at first located at some depth, and is seen between the abdominal muscles and a large cutaneous muscle. Moreover, it is composed of three distinct parts, which are placed end to end and parallel with the axis of the subject in the following order: (1) The gland; (2) a long reservoir; (3) an extracutaneous tip serving as a tubule. The gland forms and secretes the milk, but it is not in order to be drawn, sucked, or discharged immediately and through its udder; the milk reaches the extremity of the gland in molecules, to be received and stored in a reservoir, as is the urine in the bladder. Then, in a slit, there is the mammillary furrow, or a kind of urethra rather than an udder. A sort of tubule well channeled throughout its length terminates the apparatus.

Now the play of this admirable and new machine is easy to understand. The entire mammillary apparatus, made of old materials, but which are varied by their state of elongation, this entire apparatus is converted into a long sack, which expels the milk with as much power as quickness. The force of pressure is conferred on the muscles that surround this reservoir. The latter, in its turn, is prepared for the emersion, and acts while the milk is accumulated in it. Finally, outside is the tubule, very well adapted to such a usage. This tubule, which is stiffened at the base through an erectile tissue, seeks and finds an accessible point for itself toward the lips of the young animal—a point where it succeeds in introducing itself. Saint-Hilaire adds that none of the nurslings of the cetacea remain, nor can remain, attached to the mother. They all go for her with open mouths to obtain their share, which each time is a single draught. . . . . In short, the young ones *drink* but do not suck the milk from the breasts of their mother, and this liquid reaches them through a mechanical process analogous to that in use among the marsupials and monotremes.

* The animal's length was 23 meters.

The relations between the mother and the young during lactation are very clearly pointed out by Mr. Scammon, the captain of a whale ship. The young one at birth, says he, measures nearly a quarter of the length of the mother, and obtains milk by seizing the nipple between the extremities of the jaws and lips, while the mother lies over a little on her side, elevates

FIG. 3.

the posterior part of her body slightly out of the water, and takes a position of rest. This manner of nursing appears to be common to all the whalebone whales. By this process two young ones can take their food at the same time. Fig. 1, borrowed from Captain Scammon, represents two young megapters in the act of nursing.

The milk of the cetacea is very rich in fatty matter, according to all the authors who have studied it. Hunter says that it is as rich as cow's milk to which cream is

added, and Jordan was struck by its abundance and its creamy appearance. Purdie reaches the same result in an analysis of the milk of the porpoise, the centesimal composition of which he finds to be as follows:

Water	41·11
Fatty matters	45·90
Albuminoids	11·19
Sugar of milk (?)	1·39

This proportion of fatty matter is exceedingly large. It is fifteen times greater than that found in the milk of the cow, and six times greater than that found in the milk of the sheep.—*Le Naturaliste.*

ANALYSES OF THE SEED OF CALYCANTHUS GLAUCUS.*

By H. W. WILEY.

BOTANICAL DATA.

Natural Order Calycanthaceæ.—Shrubs with opposite, simple, entire, exstipulate leaves. Flowers purple, sometimes pale, sweet scented, solitary, terminating short branches. Sepals and petals similar, indefinite, united below into an inversely conical cup. Stamens indefinite, inserted on the inner margin of the cup. Pistils distinct, indefinite, one or two ovuled, inserted on the sides and bottom of the cup within. Fruit made up of one to many achenia inclosed in the enlarged calyx-cup. Species four, all American.

C. floridus, L.—Leaves oval to oblong, softly downy beneath. Rich uplands from North Carolina to Mississippi.

C. glaucus, Willdenow.—Leaves oblong ovate to ovate lanceolate, conspicuously taper pointed, glaucous beneath, roughish above. North Carolina to Georgia, in the mountains.

C. laevigatus, Willdenow.—Leaves oblong, either blunt or taper pointed, bright green and glabrous, or nearly so, on both sides. Flowers one to one and one-half inches long. Pennsylvania and southward along the Alleghanies.

C. occidentalis, Hooker & Arnott.—Leaves of the form of C. laevigatus, not shining beneath, glabrous above. Flowers one inch or more long. Northern California and northward.

The seeds are in pods, from eight to sixteen in each pod.

The weight of one hundred seeds unhulled, was found to be 21·1964 grammes. The average weight of each seed is, therefore, about 200 milligrammes.

In preparing the seeds for analysis they were first removed from the pod and then carefully hulled. The pods, hulls, and kernels were examined separately.

The pods and hulls were ground in a drug mill and passed through a ½ mm. mesh sieve. On account of the great quantity of oil in the kernels, it was found impracticable to treat them as described above. They were, therefore, reduced to as fine a powder as possible on an iron plate ore pulverizer and the oil removed by petroleum spirit. After the removal of the spirit the deoleated residue was ground to a fine flour and passed through a ½ mm. mesh sieve.

The analyses of the pod, hull, and kernel gave the following data:

COMPOSITION OF THE POD.

	Per cent.
Moisture	9·03
Petroleum spirit extract	3·07
Sulphuric ether extract	3·25
Absolute alcohol extract	1·73
Eighty per cent. alcohol extract	1 87
Fiber insoluble in dilute acid and alkali	29·26
Albuminoids	5·25
Ash	4·24
Digestible fiber, starch and undetermined, by difference	42·26

COMPOSITION OF THE HULLS.

	Per cent.
Moisture	11·39
Petroleum spirit extract	1·22
Sulphuric ether extract	0·30
Absolute alcohol extract	0·54
Eighty per cent. alcohol extract	1·09
Albuminoids	2·63
Fiber insoluble in dilute acid and alkali	30 71
Ash	1·72
Digestible fiber, starch, etc., by difference	50·40

COMPOSITION OF THE UNEXTRACTED KERNELS.

	Per cent.
Moisture	5·36
Petroleum spirit extract	47·08
Ether extract	1·29
Absolute alcohol extract	9·69
Eighty per cent. alcohol extract	2·48
Fiber	1·36
Ash	1·08
Albuminoids	23·62
Digestible fiber, starch, and by difference	8·05

COMPOSITION OF THE EXTRACTED KERNELS.

	Per cent.
Moisture	3·52
Petroleum spirit extract	3·64
Ether extract	0·31
Absolute alcohol extract	17·33
Eighty per cent. alcohol extract	6 33
Fiber	2·85
Ash	4·69
Albuminoids	42·31
Digestible fiber, starch, and by difference	13·00

The above data show that the kernel of the calycanthus possesses remarkable qualities. The small quantity of undetermined substances is not remarkable when it is remembered that a considerable quantity of albuminous matter is extracted by alcohol, and is, therefore, counted twice in the summary. The same remark may be applied to the alkaloid present in the seed, which will be described further on. The almost entire absence of starch is a noteworthy characteristic of the calycanthus flour. When a small portion of it is boiled with water, cooled, and treated with a solution of iodine, only a faint reaction is produced. Starch is, therefore, present in extremely small quantities.

The percentage of oil is very large. Dr. Eccles, to whose discovery of the alkaloid I will soon refer, reported 39 per cent. of oil. We found in most careful extractions with petroleum spirit over forty-seven per cent. Add to this the portion given up to ether, and it is seen that practically the hulled seed is one-half ether extract. The character of this oil is described further on.

The large proportion of albuminoids is also a marked property of the seed. It contains nearly twice as much of this valuable substance as wheat.

The quantity of sugar (dextrose, sucrose, and dextrine) in the seed is also large, and from the analysis it is easy to see why the "bubby" berries are so greedily sought after by cattle.

The separation and determination of the different sugars has not yet been completed.

OIL FROM CALYCANTHUS SEED.

The oil from calycanthus seed has a beautiful faint yellow color, and when extracted with an appropriate solvent and purified, a peculiar odor.

The specific gravity of the purified oil, extracted by petroleum spirit, compared with water at the boiling point, was found to be 0·9058. The specific gravity of the expressed oil in similar conditions was 0·9110. The higher specific gravity of the expressed oil was doubtless due to a trace of moisture which it contained, it having been simply warmed and filtered before the specific gravity was taken.

Five grammes of the oil tested for volatile acid showed the absorption of only 0·2 c. c. of N/10 barium hydrate solution. The oil may, therefore, be said to be entirely free from volatile acids.

The iodine absorption of the oil was found to be as follows:

For the crude expressed oil, 129·53 per cent.; for the purified extracted oil, 128·66 per cent. In respect of its iodine coefficient, therefore, calycanthus oil occupies a mean position between cotton and flaxseed oils.

The crystallizing point of its fatty acid was found to be 12·5°.

Judging by its iodine coefficient, calycanthus oil would be a mild drying oil, but no experiment to determine this point has yet been made. The iodine absorption being so much greater than would be required for olein alone, shows the presence of lin-oleic acid or some homologue thereof.

The refractive index of the oil determined by the Pulfrich refractometer at 28° is 1·47351. The index of pure water determined at the same degree is 1·33338.

THE ALKALOID IN CALYCANTHUS SEED.

Dr. R. G. Eccles, of Brooklyn, N. Y., has discovered in the seed of the calycanthus an alkaloid which he has named calycanthine. His attention was called to this substance by a paper of E. E. Sterns on "The Fruit of Calycanthus," published in the "Bulletin of the Torrey Botanical Club," for August, 1888, p. 205. The poisonous character of these seeds was called to the attention of Mr. Sterns by Mr. J. H. H. Boyd, of Cagle, Tenn., in a letter written November, 1887. Mr. Boyd's letter is as follows:

"Hundreds of cattle and sheep have died here in the past five years from 'bubby' (the eccentric name of the shrub). The seeds only are poisonous. When a brute gets a sufficient dose, from five to ten well filled pods, it makes for the nearest water and often falls dead while drinking, or it may live three or four weeks and then die. The symptoms are like those of a man extremely drunk, except that any noise frightens it. Stamp the ground hard close to a brute poisoned with 'bubby,' and it will jump and jerk and tremble for several minutes. That is our method of telling when they have taken it. The eyes turn white and glassy, and while lying they throw back the head and look as if dead already. 'Bubby' does not seem to hurt a brute so much if it cannot get water. Our best remedy is apple brandy, strong coffee, and raw eggs poured down as soon as possible after finding. It is certain that 'bubby' is the most poisonous of any shrub or weed in existence here, from the fact that when the brutes have once eaten it they will take it every time they can get it. It grows on every hillside, along all branches (creeks), in every fence corner, and almost everywhere."

Dr. Eccles' first paper was published in the *Western Druggist* of January, 1887, on p. 15. The alkaloid in the seeds is evidently not a very virulent one, since twenty of the seeds were eaten without any toxic symptoms being manifested.

The alkaloid is described in this paper as being slightly soluble in water and very soluble in ether or chloroform. Its salts are insoluble in the latter substance, but very soluble in water. Its most characteristic color is the development of a green color on the addition of a strong nitric acid.

A second paper by Dr. Eccles was published in the *Druggist's Circular and Chemical Gazette* for March, 1888, on p. 65. He describes the method of extracting the alkaloid as that of Dr. Lyons.

"The finely powdered seeds were first macerated for twenty-four hours, with occasional shaking in a mixture of ether, alcohol, and ammonia. After allowing the mixture to settle, the clear solution was decanted and evaporated to a small bulk, then stirred or shaken with dilute sulphuric acid and concentrated ether. This was again evaporated until all the ether was gone, when it was filtered. The clear acid solution was neutralized with ammonia shaken up with ether, allowed to settle, the ether decanted from the surface into a porcelain evaporating basin, where it was allowed to spontaneously evaporate and leave the alkaloid. This alkaloid, for several hours after the last of the ether had gone, had a strong, distinct odor of pyridine, so that it was probably contaminated with that volatile alkaloid of tobacco."

The alkaloid in some of the seed having first been extracted by alcohol until it gave no further test, it was treated with a little sulphuric acid, by which an additional alkaloid was extracted, leading Dr. Eccles to suppose the existence of more than one in the plant. Dr. Eccles also states that the acid solution of the alkaloid precipitated by ammonia did not yield the alkaloid by shaking with ether, an experience which is entirely contrary to my own. About 2 per cent. of the alkaloid was found by Dr. Eccles.

Mr. Boyd wrote to the department in March, 1889, for information in regard to the calycanthus poison, and at his instigation I communicated with Dr. Eccles on the subject. He kindly gave me all the information which he had in regard to the matter, and under date of March 20, 1889, wrote as follows:

"I hated to give the investigation up, as it has just reached the most interesting point, but you know the saying, 'man proposes and God disposes.' After the rush is over, say some three months hence, I will do some work on the subject, and would, therefore, beg you to let me know from time to time what you discover."

Since that time I have not seen any report of any further work of Dr. Eccles, and my contribution at the present time is certainly not intended to take the place of any investigation which he has made or may make in the matter. The methods which I used in isolating the alkaloid are as follows:

Alkaloid in Extracted Oil.—Since nearly all the alkaloids are more or less soluble in fixed oil, I was led to suppose that the calycanthus seed, containing so large a percentage of fixed oil, might yield some of its alkaloid to that oil on extraction with petroleum spirit. To see if this assumption were true, a portion of the extracted oil, after being freed as nearly as possible from petroleum, was shaken with an equal volume of dilute sulphuric acid (1 to 50) and the acid liquid separated from the oily layer. This acid solution was shaken with petroleum ether to remove any fat which it might contain. The residual acid solution was made strongly alkaline with ammonia and shaken with ether. The ethereal solution was evaporated and the alkaloid thus obtained dissolved in dilute sulphuric acid, and treated with a solution of iodine in potassium iodide. A dense brown precipitate indicated the presence of an alkaloid.

Five hundred grammes of the oil were next washed with 1,000 c. c. of dilute sulphuric acid (1 to 50) in successive portions. The acid washings were shaken with petroleum to remove any trace of oil. The solution was then made strongly alkaline with ammonia and shaken four times with 150 c. c. of ether. The ether was evaporated in a tared dish, and the extract dried at 100° was found to weigh 0·1366 gramme. The percentage of alkaloid, therefore, in the oil was 0·027.

The above reaction shows that the amount of alkaloid extracted by the oil, when the latter is removed by petroleum ether from the seed, while important from a chemical point of view, would not appreciably affect the quantitative determination of the alkaloid in the seed.

Alkaloid in the Seed.—The seeds were carefully removed from the hulls and the two substances examined separately for alkaloids and bitter principles.

Alkaloid in the Kernel.—The seeds removed from the hulls were powdered as finely as possible, considering their oily state. The fat was then extracted by means of petroleum spirit. The dry residue was finely powdered and passed through the fine mesh sieve employed in the preparation of vegetable substances for analysis. 10 grammes of the powdered seed were then weighed into each of six flasks. The first flask was treated with 100 c. c. of ether; the second with 100 c. c. of alcohol, 95 per cent.; the third flask with 100 c. c. of chloroform; the fourth with a mixture of ether, alcohol and ammonia; the fifth with 100 c. c. of dilute sulphuric acid (1 to 50); the sixth flask with equal parts of ether and alcohol. The flasks were all tightly corked and placed in a warm room, the temperature of which was 35°. They were shaken at frequent intervals for four days, and then treated as follows:

The liquid portions of Nos. 1, 2, 3, 4, and 6 were filtered into evaporating dishes, and the filter papers containing a portion of the solid substance were returned to the flasks. The same quantity of the reagents was again added and the flasks treated in the same way as indicated. The residue was then washed with frequent shaking by the same quantity of the particular reagent used for each one. The finely powdered seed wae thus extracted for six days with the solvents, and washed thoroughly with the same solvent.

No. 5, containing the sulphuric acid reagent, was found to be in the state of an emulsion. It was therefore found impossible to filter off the liquid portion. The whole mass was made strongly alkaline with ammonia, and treated at once with 200 c. c. of ether. The emulsion separated very slowly, but after its separation the ether layer was poured off into an evaporating dish and evaporated to dryness. This treatment with ether was repeated eight times, and the whole of the ethereal solution evaporated in the same dish. Abundant crystals of the alkaloid were shown by the first evaporation. The alkaloidal extracts from all the samples were then treated as follows:

They were thoroughly washed in successive portions of dilute sulphuric acid (1 to 50), about 100 c. c. of the acid being used in all. The acid washings were then shaken in a separatory tube twice with 50 c. c. of ether, and the ethereal layer removed. In this way the solution was freed entirely of fat and other substances soluble in ether, including, perhaps, a trace of the sulphate of the alkaloid. The remaining portion was now made strongly alkaline with sodic hydrate, and shaken with successive portions of ether of about 50 c. c. each for five times. The extracts, which were now in a very pure state, with exception of No. 1, were evaporated to dryness in tared glass dishes and weighed. The percentages of alkaloid obtained by the six different methods were as follows:

No. 1	0·79	per cent.	alkaloid,	very	impure.
" 2	1·20	"	"	"	pure.
" 3	1·85	"	"	"	"
" 4	2·35	"	"	"	"
" 5	4·25	"	"	"	"
" 6	0·22	"	"	"	"

In No. 4 only one extraction of four days was made. In treating the residue the second time with 100 c. c. more of the same reagent, the flask was broken. The high percentage obtained shows that this method of extraction completed would have yielded almost as large a percentage of the alkaloid as was obtained in No. 5.

The residue from Nos. 1, 2, 3, and 6 of the above samples were treated with dilute H_2SO_4 for twenty-four hours, filtered out, and re-extracted with same reagent. The acid solutions were treated as in No. 5, and the percentages of alkaloid obtained were as follows:

No. 1	1·98	per cent.	alkaloid,	pure.
" 2	0·76	"	"	"
" 3	1·30	"	"	"
" 6	1·83	"	"	"

* Contributions from the Chemical Laboratory of the Department of Agriculture.

The alkaloid thus extracted by H_2SO_4 did not show any difference in composition from the other extracts.

Another extraction was made by forming a paste of the flour with lime, and extracting with an equal mixture of ether and alcohol under pressure at 80°. The percentage of alkaloid obtained by this treatment was 2·58 (alkaloid pure). The residue was neutralized and treated as in the other cases by dilute H_2SO_4. The percentage of alkaloid obtained was 0·39 per cent.

The percentages of total alkaloid obtained in all extractions were:

No. 1	2·77	per cent.
" 2	1·96	"
" 3	2·15	"
" 4	2·35	"
" 5	4·25	"
" 6	2·05	"
" 7	3·07	"

Calycanthine crystallizes from ether in feathery masses on the sides of the dish, presenting the appearance of a diminutive pine forest. These feathery crystals form very rapidly and present a beautiful appearance. On slower evaporation the bottom of the dish is found to be covered with triangular crystals, which appear to be hemihedrae from oblique octohedrae. The exact crystalline structure will be shortly determined.

SPECIFIC ROTATORY POWER.

The alkaloid being practically insoluble in alcohol and water, the determination of its specific rotatory power is deferred until the properties of its salts can be studied.

PERCENTAGE COMPOSITION.

The following numbers were obtained for the percentages of the elementary substances present in the alkaloid:

Carbon	42·13	per cent.
Hydrogen	7·75	"
Nitrogen	16·22	"
Oxygen (by difference)	33 77	"

The above figures lead to the following formula for calycanthine, $C_{15}H_{16}O_{11}N_2$.

	Calculated for $C_{15}H_{16}O_{11}N_2$.		Found.	
C	41·86	per cent.	42·13	per cent.
H	7·75	"	7·89	"
N	16·28	"	16·22	"
O	34·11	"	33·76	"

Alkaloid in the Hulls.—Ten grammes of the hulls were examined for alkaloids by extraction with dilute H_2SO_4 and subsequent treatment as indicated above.

The percentage obtained was 0·83. The alkaloidal principle was amorphous, but contained traces of calycanthine as revealed by the color tests to be mentioned. The nature of the amorphous alkaloidal principle has not yet been determined.

Color Reactions.—Calycanthine exhibits the most remarkable series of color tests of any known alkaloid.

Dr. Eccles described the beautiful green color produced by nitric acid. In extending these tests I obtained the following results:

H_2SO_4, pale yellow.

HNO_3, bright green (persistent).

$H_2SO_4 + C_{12}H_{22}O_{11}$ (sucrose), fine purple (persistent and changing finally to blue).

$H_2SO_4 + K_2Cr_2O_7$ fine blood-brick red.

Dextrose, maltose, etc., gave also the furfurol reaction, but without so marked a purple as with sucrose.

The presence of sugar in the seed renders it possible to secure the furfurol reaction in the raw seed by the simple application of H_2SO_4.

The examinations necessary to complete the investigations, and to determine the crystalline forms of the alkaloids and the properties of its compounds with common acids, will be made at as early a date as possible. We hope also to be able to study its physiological effects.

In these investigations I have been assisted by Messrs. Horton, Trescott, Krug and Sanborn.—*Amer. Chem. Jour.*

IRON AND ALUMINA IN PHOSPHATES.

E. GLASER.

(*Zeitschr. f. angew. Chemie*, No. 22, 1889.) The process for the estimation of iron and alumina in phosphates, as now practiced, is not applicable to any variety of phosphate, and therefore not very useful. Its shortcomings have shown themselves more particularly in the last few years, when many samples of Belgian and similar phosphates are on the market. The results are somewhat dependent on the amount of acetic acid used. Then aluminic phosphate is somewhat soluble in excess. This conventional process is as follows:

The precipitate insoluble in acetic acid is filtered off, washed with cold water, and then dissolved off the filter with hydrochloric acid. After adding a little microcosmic salt the liquid is rendered alkaline with ammonia and then mixed with acetic acid. The precipitate is washed, dried, and ignited, and half of its weight is called iron and alumina. No wonder analysts differ in their results from 1 to 3 per cent. Not only, however, is the error solely due to the slight solubility in acetic acid, but also to the fact that in the original sample the iron is not always in combination with phosphoric acid. When such a solution is precipitated with ammonia, the lime and magnesia are precipitated as phosphates, which is also the case with the iron and alumina, if there is a sufficiency of phosphoric acid. This, however, is not always so, and then there forms a precipitate of ferric and aluminic hydrate, which redissolves in excess of acetic acid, and so gets lost.

Then again the ferric acetate has a solvent action on ferric phosphate. If too little acetic acid is used, the precipate may contain lime, and the result is equally faulty.

(*Note by abstractor*: Iron and alumina phosphates will not properly come down with ammonia and acetic acid if the phosphate contains organic matter, which is very often the case. This being absent, all the iron and alumina will certainly come down, except in cases where there is a want of phosphoric acid.)

The author now tried to find a process which will dispense with the acetic acid, and succeeded by the use of alcohol as follows: 5 grammes of phosphate are dissolved as usual in 25 c. c. of nitric acid of 1·2 sp. gr., and 12·5 c. c. of hydrochloric acid, and diluted up to 500 c. c.; 100 c. c. of filtrate (= 1 grm. sample) are put into a 250 c. c. measure and mixed with 25 c. c. of strong sulphuric acid. After standing for about five minutes and occasional shaking, 100 c. c. of alcohol are added, and the whole well shaken.

After cooling, alcohol is added up to the mark, but as there is always a little contraction, it will be found necessary to later on add more spirit. After at least standing for half an hour the liquid is filtered, and 100 c. c. (= 0·4 grm. sample) are evaporated in a platinum dish till alcohol is expelled. The acid fluid is rinsed into a beaker with about 50 c. c. of water, and heated to boiling. After cooling, a little ammonia is added to alkaline reaction, and if necessary the excess of ammonia is expelled by boiling.

The precipitate is now collected, well washed, dried, and ignited. It consists of pure ferric phosphate and pure aluminic phosphate. The iron phosphate can be determined by a volumetric estimation, say with permanganate.

The test analyses given are very satisfactory, more so than the analyses performed by the conventional process.—*L. De K. in The Analyst.*

[ANNALS OF SURGERY.]

THE ASEPTIC APPLIANCES AT THE HOTEL DIEU IN LYONS.

IN an elaborate article,* Professor Poncet, of Lyons, France, describes what he has been able to accomplish in the construction of a new operating theater at the Hotel Dieu, of that city. In planning the building, he aimed to meet all the demands of modern surgery to the highest possible degree. To inform himself fully, he visited the clinics of other countries, principally Germany, Switzerland and America. He aimed at the suppression of dangers to which all wounds are exposed—infection by the air and infection by contact. This double result was secured by the general disposition of the room, by its arrangement and by the rigorous adoption of everything which would assure asepsis and antisepsis.

Quadrangular in form, the theater measures about 28 feet in length by 19 in width. Its extreme height is about 22 feet. A single window, 13 feet high by 7 feet wide, allows an abundance of light to enter both from above and laterally. The window opens to the east, and consists of eight large panes held in a metallic frame which represents the minimum of breadth to interfere with the light.

The ventilation of the room is secured mainly by means of this window, which looks out on the Rhone, and is always kept open except at the time of operating, as is also a double glass panel, forming the upper part of a large door at the opposite end of the room. Artificial light ample for all purposes is obtained, when needed, from a Wenham lamp of great power hanging from the center of the dome-like ceiling; a small burner is also placed over each of the wash basins in two of the corners.

The walls, to the height of nearly five feet, are lined with large sheets of glass, closely joined together. These sheets are nearly an inch thick and present no elevation or depression, but form a continuous surface, polished like a mirror. Their inner face has been painted a rich brick red, with a broad band of a deeper red as a border. This color not only renders the glass more pleasing to the eye, but also renders every soiled spot more readily recognizable. Above this, the walls are covered with a smooth plaster of a rose gray tint.

On the right of the entrance is placed a plate of milk white opaque glass, which is used for a table for demonstrating specimens. Five glass plates, from a quarter to a third of an inch in thickness, are placed about six and half feet from the floor on nickel plated brackets firmly fixed in the wall. They are separated from the wall in their entire length by an interval of two inches, which not only makes them easier to clean, but obviates the accumulation of dust in the interspaces. Upon them rest large bottles, containing the antiseptic solutions, and metal cases in which the antiseptic dressings are kept. The supports are of iron, nickel plated, and very easily kept in order. Near the bottom of each receptacle for antiseptic solutions is an orifice, in which is placed a branching tube, to the projections of which the rubber irrigation tubes are attached. On the outside in very distinct red letters are inserted the names of the contents of the receptacles.

The theater is connected with the hospital by a pair of nickel plated iron doors. They not only keep out external noises, but they also fulfill the same aseptic indications as the glass slabs. They are not subject to alterations like those of wood, and always present a brilliant polish. M. Poncet asks if this polish is not the prelude of asepsis, and remarks that his four months' experience convinces him that his opinion was correct. The luxurious appointments and the careful regard for asepsis have made a profound impression upon his attendants, and, in consequence, the room, after four months' use, is in identically the same state as when the first operation was performed in it.

The floor is composed of Vicat cement, which was considered preferable to the mosaic employed so much in other countries, because it is cheaper, less slippery, and of very great endurance. Grayish white in color, it presents numerous points which prevent slipping. At the sides of the room this floor meets the glass slabs of the wall in a curve. The floor has a fall toward the center of about one and a half inches. From the four blunt angles of the room proceed four trenches toward the center, terminating in a central opening closed by a bronzed iron grating. These principal trenches receive a number of accessory trenches, which makes the flow of liquids easy. They then pass into a conduit under the floor, the care and cleansing of which is made very easy by certain openings usually closed by metal plates; these openings are near together and situated in the course of the conduit to a considerable depth. A trap placed at one point in this pipe insures disinfection and prevents regurgitative emanations from the sewer. This disinfection is further insured by the free flow of fluids from the wash bowls which pass in the same way.

The floor is kept aseptic by daily cleansing with water and brush after the operations, and by weekly washing with 5 per cent. carbolic solution.

A large marble grate, without mouldings or other decorations, serves for a coke fire of sufficient power to maintain in the coldest weather a temperature of 65° to 68° F. The various gas heaters for warming water, sterilizing, dressing, etc., also add to the temperature. M. Poncet thinks that an operating room where patients are sometimes exposed completely and for a considerable period at a time is never too hot.

It is important, however, that the surgeon and his assistants should be able to work without inconvenience. So he considers a temperature of 65° to 68° F. sufficient; but for more prolonged operations, he always takes the precaution of covering his patient with rubber sheeting, leaving only the field of operation exposed, and surely preventing chilling.

The furniture of the room is very simple. Glass and iron, nickel plated or bronzed, are here again the only material used. Two fixed glass tables of different dimensions stand at an inch and one-half from the wall, the interspace preventing the accumulation of debris. They hold hand basins, glass cases containing reels of ligatures, bottles for drains, etc. Another table is covered with various substances—ether, iodoform, tincture of iodine, etc.— of daily employment; before it stands at an operation the sister charged with handing the various solutions and preparing the dressings. The glass tops of these tables are an inch thick, and they rest upon cylindrical metal legs; the same brick red color seen upon the walls is repeated here. Other tables have two shelves, and are used for instruments, dressings, cushions, etc., during the operation.

There are but few chairs, and they are made of bronzed iron, as also are the stools. One of the chairs is especially designed for the seat of the patient during operations upon the face or head which do not require anæsthesia.

The majority of operations naturally are performed upon an operating table. This too is original in conception. In its construction four considerations were sought to be satisfied:

1. Asepsis, easy to obtain and maintain.

2. Such an arrangement that the blood and other fluids might flow away rapidly without soiling the surgeon or his assistants or the patient.

3. Great simplicity in the disposition of its various parts and the suppression of every kind of mechanism.

4. Perfect solidity and stability without excluding great mobility.

The table, which measures 78 inches in length by 26 inches in width, stands 36 inches from the floor, and consists exclusively of glass and nickel plated iron. It is composed of four triangular plates of glass, inclining to a common center by a declivity of an inch and a quarter. They converge at their apices to a central opening one inch in diameter, in which is fixed a metal ring through which fluids may pass into a rubber tube to the floor. It is supported by four legs connected, for the sake of stability, by cross bars. It moves freely upon large casters, and in spite of its 280 pounds weight, a single person can move it with ease. There are no arrangements for varying its elevation; if a change in the attitude of the patient is desired, it is accomplished at will with the use of rubber cushions of various sizes. At the head of the table where stands the assistant deputed to administer the anæsthetic swings a basin large enough to contain everything needed for anæsthesia—ether, chloroform, forceps for pulling out the tongue, etc. Closed, it disappears under the table, but a very slight traction places directly under the hands of the anæsthetist all the objects which he may need. The table is also measured off into centimeters in its entire length, so that measurements may rapidly be taken. On either side are slots for the reception of movable brackets which can be attached or detached at will. They hold plates of glass on which in course of an operation the instruments, small cushions, etc., may be placed. The least spot, the slightest soiled point, is readily apparent on the glass and nickel.

During an operation a mattress three inches thick is placed on the table, agreeing exactly with the dimensions of the table; this mattress is composed of hair, covered with rubber. It is pierced through by various openings for the flow of liquids.

A railing of bronzed iron fastened to the floor, composed of three parts capable of being readily and firmly fastened together, is placed about the table during operations. It has the form of a horse shoe and provides a free space next to the table, in which the surgeon and his assistants may move with ease, while spectators are prevented from approaching too near.

Another operating table is provided for those cases in which the surgeon wishes to work between the patient's thighs. It is also of glass with a nickel plated frame work, and measures 48 inches wide. At its upper extremity is a receptacle for the anæsthetist's tools, as in the other table. On its two lower legs are placed two metallic rods with foot rests; the level of the rods may be raised or lowered as desired, and they may be swung around laterally to any desired position or slipped entirely around under the table.

In connection with the rubber cushions he uses exclusively for varying the attitude of the patient, Mr. Poncet remarks that they offer among other advantages that of ready asepsis; the rubber sheeting can be readily scrubbed and washed without inconvenience and without alteration with various antiseptic solutions generally employed. He also takes the precaution before using them to cover them with a compress of sterilized gauze which has been wrung out in a 1-1000 sublimate solution.

For transporting the patient, he uses a rolling bed made after the plan of Socin.

Mr. Poncet usually uses basins of his own devising, which have the advantage of adapting themselves to the figure. A large cylindrical zinc receptacle 30 inches in diameter receives the soiled dressings. A dressing is thrown into the receptacle as soon as it is removed, to be burned a few moments later. The bottom of this apparatus is pierced with holes the size of a two franc piece, which renders its cleansing very easy. Every day, after an operation, this toilet is made with great care.

There are in this operation hall, therefore, no corners and no placards in which dust may collect. The walls,

* Une salle d'operations a l'Hotel Dieu de Lyon. Par le Dr. Antonin Poncet, Professeur a la Faculte de Medecine de Lyon; Chirurgien en Chef de l'Hotel Dieu.

the shelves, the tables, the utensils of all kinds, are absolutely smooth, without any kind of decoration. The substances comprising them, glass and metal, being washed daily, seem to furnish the very best conditions for obviating *infection by air*. This apparent superfluity, this search for details, has been imposed upon the operators by the numerous causes of surgical poisoning to which patients are exposed in a great hospital service, where the activity is considerable, and where in the same locality are both infected and non-infected wounds.

While, however, he fears infection by air, he takes more particular precautions against infection by contact. These are considered in three different classes:

1. The hands of the surgeon and his assistants.
2. The instruments.
3. The sponges, tampons, and dressings.

In addition, the patient himself may be considered when the region operated upon has not been disinfected with care, or at any time by accident the field of operation has been brought into contact with bedding or soiled clothing.

For asepsis of the hands, he provides a dresser with three large basins set into a plate of glass similar to those of which the tables are formed. One of these basins provided with a single glass faucet is reserved for washing the hands with 1-1000 sublimate solution. This solution is contained in a large glass bottle holding 50 liters, which is placed directly above the dresser, from which the antiseptic solution runs as desired by a rubber tube into the subjacent basin. Cold water, hot water, and boiling water are also furnished in abundance as desired by four faucets. The hot water and boiling water are obtained from a large receptacle of 100 liters capacity.

In order to obtain entire asepsis, all solutions are prepared with boiled water. The soap and the nail brushes are placed upon little grates in small galvanized pans. For disinfection of the hands, he requires repeated washings with hot soap and water, immersion for several seconds in alcohol 90°, and finally prolonged bathing with 1-1000 sublimate solution. The surgeon and every person that comes in contact with the patient must of course be clothed with a gown absolutely clean and absolutely aseptic. He uses for himself a gown with the sleeves ending above the elbow, which makes it necessary to disinfect his entire forearm.

He is careful to avoid keeping his instruments in the old padded cases—indeed, he possesses but two cases, an amputation case and a resection case. The case in this instance is nickel plated, and the instruments lie in metal racks.

All instruments are provided with a smooth metal handle, without ornament, and without even the maker's name—as plain as possible, either plated with nickel or with German silver. Instruments employed on the living are not allowed to be used for partial necropsies—sawing of bone, incision of tumors, and the like. He has, moreover, two receptacles of zinc, labeled *Pieces anatomique*, designed to receive immediately upon their ablation all human *debris*. One of them will accommodate an entire extremity, the other is reserved for tumors and pathological specimens of small size.

Some hours before operating, the instruments are all sterilized by heat in a sterilizer which M. Poncet describes very minutely. He claims to have had the best of results from this instrument and recommends it unreservedly.

This paper then enters with the greatest detail into a description of all the antiseptic materials, solutions, tubes, and other drains, and closes with a reference to the application of some of these points in individual classes of operations.

By this organization he claims to be sure of the absolute disinfection of all objects, of all the substances which can be at a given moment in contact with the wounded. It may be thought that he is over-careful. This he considers an error, because it is not possible to take sufficiently into account all the numerous causes of infection in the midst of which operations are performed. This very minuteness avoids all the multitude of conditions which have been so great a source of mortality hitherto. He would even go further, and calls for the immediate erection of a second operating theater for suppurating cases and for those affected with phlegmons, erysipelas, etc. A goitre, for example, can never be removed, a large joint can never be laid open, without fear, upon the same table and in the same room where a diffused phlegmon had been incised, or a gangrenous limb amputated.

JAMES E. PILCHER.

EFFECT UPON THE HUMAN BODY OF A DIET CONSISTING ENTIRELY OF LEAN MEAT AND WATER.

By J. W. GOOD, Professor of Clinical Surgery, Manitoba Medical College, and Physician to the Winnipeg General Hospital.

IN the *Lancet* of November 9, I notice an interesting article on the above subject. To the question "Can life and health be sustained indefinitely on a diet consisting of meat and water?" the reply must be in the affirmative. Not only is this true of natives of certain districts whose progenitors lived on such a diet, and where no other was obtainable, but it is also true of Europeans who locate in such places. In the Athabasca district and in the Mackenzie River region of North America the servants of the Hudson's Bay Company habitually live, some of them on a diet of meat alone, and some of them solely on fish, thus depending on the natural food supply of the country in which they happened to be stationed. They have lived in the full possession of great bodily and mental vigor on such a diet for periods of twenty and thirty consecutive years. Those living on fish alone enjoyed, if anything, slightly better health than those whose diet was limited to meat. They were singularly free from constipation and all digestive troubles, as well as every other indisposition. No vegetables of any kind were used. They were allowed one pound of flour in the year, which was always consumed in the form of a pudding on Christmas day. They were also allowed tea, but in the Mackenzie River district the amount supplied to each man was only one pound in the whole year, so that this article may be fairly disregarded. The experience of diet thus gained throws much light on the etiology of scurvy, which is unknown where the diet is thus limited to fresh fish or meat, while it is quite prevalent at a post known as York Factory. It is accounted for by the following circumstances. At this post the diet consists largely of geese, which migrate there late in the spring, returning south in the early autumn. Hence the inhabitants kill and salt a sufficient supply to last until the supply of fresh geese again becomes accessible. Scurvy always makes its appearance in the winter, and especially in the spring, thus affording strong proof of the view popularly held that scurvy is chiefly due to the use of salted meats, as bacon, etc. The life led by these men is one of great activity in the winter and comparative ease in the summer, while those stationed at the posts in the capacity of clerks and officers take little exercise at any time. These are facts which can be fully proved by the testimony of numerous gentlemen who live here, some of whom have had the experience of such a diet themselves. One gentleman is Mr. James Stewart, a druggist, of this city, who lived on fish alone for four years; and another, Mr. Wm. Brass, of St. Andrew's, Manitoba, who lived and enjoyed unimpaired health for twenty consecutive years. They are both gentlemen verging on seventy years, and are in the full enjoyment of a green old age.—*Lancet*.

ABSCESS OF THE ANTRUM.

"A NEW diagonistic sign of abscess of the antrum was brought forward by Dr. T. Heryng, of Warsaw, at the Congress of Otology and Laryngology, held at Paris, during September. The patient is placed in a dark room and his mouth lit up with a small electric lamp, placed above the tongue. Two bright red spots will then appear below the lower eyelids. If the cavities are filled up with pus, or occupied by a tumor, these red spots will not appear, but, as soon as the pus escapes or the cavity is washed out, the spots again become visible."—*Medical and Surgical Reporter*.

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